ELECTRICAL REVIEW

[ILLUSTRATED.]

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ELECTRIC LIGHT, TELEPHONE TELEGRAPH AND SCIENTIFIC PROGRESS.

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New Lamps of the Edison Company.

The march of improvement in the Edison system has resulted in the perfecting of a new type of lamps of much greater economy than those which have been made by them so many years. Broadly stated, the new High Economy lamp of the Edison Company carries with it a saving of one-third the power required for the former style, and whereas the company formerly guaranteed 8 to 16 candle power lamps to the mechanical horse power, they now guarantee 12 for an expenditure of the same power, or 15 to the electrical horse power. The old plants of the company are being rapidly fitted with the new lamp, which, of course, marks in the mind of the user of the plant the fact that electric lighting is making substantial progress. The new 16 candle power Edison lamps range from 90 to 125 volts and require only $3\frac{1}{10}$ watts per candle power.

These facts have an important bearing on the relations of electricity with commerce.

Figure 1 is a cut of the Edison new ½ ampere lamp.

The 100 candle lamp shown in Fig 2. is also one of the new type of lamps, and ranges from 90 to 125 volts, requiring an energy of $3\frac{1}{10}$ watts per candle power.

The lamp shown in Fig 3 is one which the advances of the storage battery art has called into being. It has been specially constructed for use in this connection, being of comparatively low E. M. F. (60 volts) and requires only 2½ watts per candle power. The Edison Company is now also making a series of lamps of similar economy for battery purposes, but running from 20 to 40 volts and from 10 to 32 candle power.

The spiral lamp shown in Fig. 4 is one that is used in connection with Edison central stations. It is of high resistance, and requires 150 volts to bring it to incandescence. When, therefore, it is run at 110 volts it gives but a dim light, and this is what is desired, the lamp being intended for a night lamp, in bedrooms and other places where only a small amount of light is desired.

Touching Telephone Charges.

Discussing, among other things, the proposition before the Ohio legislature to limit telephone charges, the Cincinnati *Commercial Gazette* says:

"There are many people who have a singularly false idea of the telephone business, and the anxiety to meddle with it is in proportion to the ignorance about it.

"One of the common notions is that the telephone is not costly, but is the matter of a wire and a tin pan and a 'hello girl' or two and a few poles. The fact is, the telephone is an exquisitely fine and expensive machine; and a piano is a plain article of furniture and simple as a work-bench compared with the wonderful mechanism of a telephone exchange.

"In this city we have perpetual service. The telephone calls are answered at all hours of the day and night, and on Sundays and all holidays, greatly to the convenience and comfort and sense of security of thousands of households, and a sworn statement shows that the annual cost of running a telephone exceeds sixty dollars—the actual cost of operating and maintaining the three thousand telephones of the Cincinnati district in 1887 being $180 631.26; average cost to subscriber, $60 21."

Growth of Telephone Business in Atlanta.

The telephone exchange at Atlanta, Ga., has been removed into new offices. For some time past, employes of the telephone company have, under the direction of District Superintendent W. J. Cole, Electrician George Cole, and Manager Gentry, been busily engaged in the construction of a new switchboard, and the arrangement of a new operating room in the rear of the old one. When work was completed, at midnight Night Chief Operator L H Lofton took possession of the new quarters, and made the first connection called for on the new board—402 on 1108. The new quarters are pleasant and commodious, and contain all the latest improvements in telephonic machinery. The new board accommodates 2,000 wires.

.... A contract has been closed with Messrs. Ruffin & Bullow, of Danville, Va., for a Thomson-Houston system of electric lights to be in operation in Oxford, N. C., by April 15.

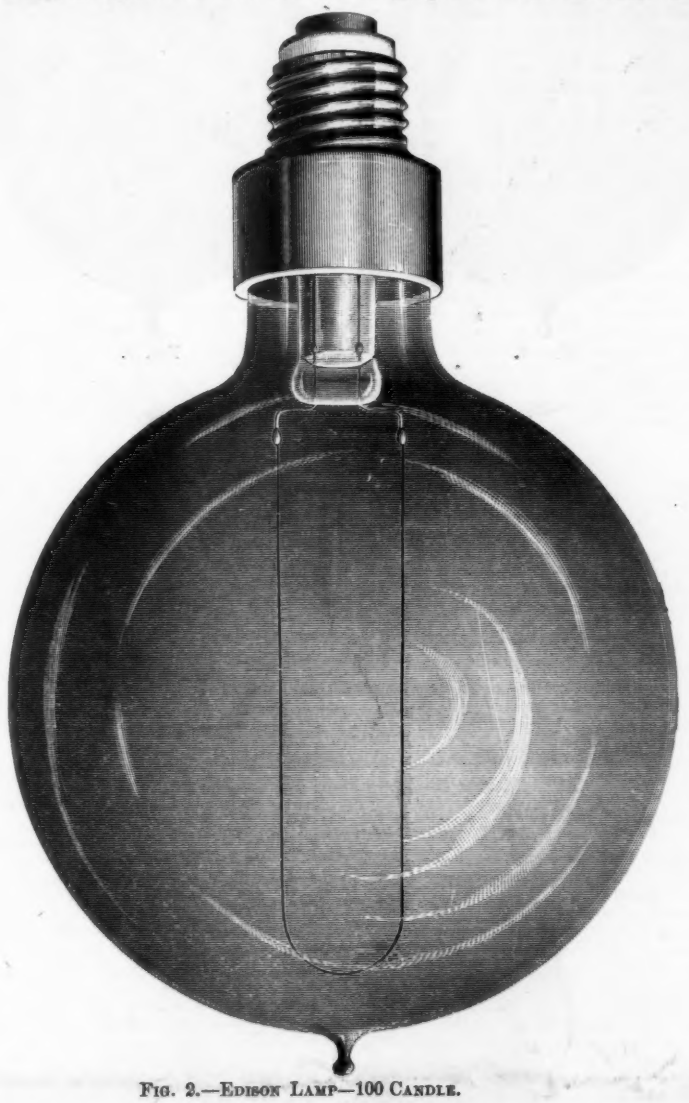

FIG. 2.—EDISON LAMP—100 CANDLE.

Graphophone Stock Supported.

The Washington *Capital's* article on Graphophone stock last Sunday created a commotion in Washington and set a great many people to inquiring further in regard to this enterprise. It also set the principal holders of the stock at work to sustain the price of it, and the result was that there was something like a bull movement started. The object seemed to be to get the market price back to 10, which is par. The officers of the company gave out a good many confident statements during the week, and yesterday afternoon a so-called auction of 500 shares, which was advertised for several days in the daily papers, took place. It is understood that the stock which was advertised was not really transferred, but simply knocked down at 10¼, in order to establish the fact that the stock is quoted above par. It is quite probable that this price will be maintained for some time to come, and that those who wish to realize at that figure can do so. It appears that only about 10,000 shares of the 60 000 have been sold in small lots, the remainder being held in large blocks, where it is likely to stay for the present. This, of course, is very creditable to the management.

THE CONVENTION.

Electric Light Men assemble in Pittsburgh to Honor the Advance of Electricity.

AN ATTENDANCE OF NEARLY THREE HUNDRED.

A Number of Exceedingly Thoroughly Interesting Papers Discussed.

NEXT MEETING WILL BE HELD IN NEW YORK.

S. A. DUNCAN WAS CHOSEN PRESIDENT, DR. OTTO MOSES CHAIRMAN OF THE EXECUTIVE COMMITTEE.

Pittsburgh, erstwhile known as the city of perennial smoke, now the proud possessor of the becoming title "city of everlasting gas," must have been almost paralyzed this week by the advent in her midst of a new and strange speaking race—men who gave frequent vent to mysterious words and phrases, unknown to her gas-inflated citizens. What a wonderful place Pittsburgh has become since they have made a pepper-box of the earth's crust hereabouts! Contrary to the practice of this, the business end of the 19th century, water is at a discount in the aggrandizement of material interests; they do not water stocks (or anything else) here; but they simply hitch a gas well to the scheme and the inflation becomes a fact, and surprisingly fills the latent capacity better than water by long odds, because it extends its plenary functions even to the pockets of the interested ones. What an Elysium this section would be for Doctor Ox!

With all his versatility and inventive powers, even Jules Verne could not do justice to the wonders natural gas has performed for this once begrimed and besooted city. Even the once apt 1 kening of Pittsburgh at night to "hell with the lid off" has become an obsolete simile: and to-day it is one of the cleanest cities in the country: Rolling mills innumerable, iron works of every description, foundries, steel works, glass factories, and a bewildering maze of miscellaneous industrial establishments, whose somber chimneys not long since vomited forth gloom striking masses of inky smoke, representing billions upon billions of foot pounds of wasted energy, are to-day fulfilling their natural functions in the most aristocratic manner, and are as clean as though they go

a Turkish bath every morning. Almost without exception every private house in this district uses the gas for all heating and cooking purposes. It is fairyland of the fable reduced to fact. Gas everywhere. Go to your kitchen stove these cold mornings, light a match, turn the gas-tap, and—pouf! you can broil a steak in three minutes. Think of that, ye suffering Benedicks of the East, whose souls are harrowed with the daily task of teasing and coaxing the sluggishness of hard coal into a semblance of life and activity, and whose *soles* bear the veteran's campaign marks of the clinging tack and enable you to count the incendiary expeditions of the winter. And envy leaves her trail not alone in this little abolition of the tack and bare feet. You should see the faces of electric light plant owners as they watch the boiler furnaces! Furnace fronts spick and span new apparently, not a trace of ashes, cinders, coal dust, and yet when opened displaying a quivering heat that fairly makes the water burst into steam. And our delegates from coal-burning districts think of their own boiler-houses, with the coal dust, ashes, and grimy firemen shoveling the filthy food into the hungry maws of the furnaces. Truly it is ground for envy.

Natural gas has certainly been a magic wand to this city, already gifted with more than her share of the goods of industrial advantage.

FIRST DAY'S SESSION.

The meeting was called to order at 12 M. on February 21, at the Monongahela House, Pittsburgh, Pa., by the president of the association, Mr. J. Frank Morrison, of Baltimore.

The president addressed the convention as follows:

Gentlemen of the Convention:—When the National Electric Light Association in its wisdom decreed that its next meeting should be held in this city, it was certainly an evidence of our faith in the stability of the business in which we are engaged.

The cheapest of coal, the natural gas—every element that nature could furnish for illuminating purposes, are here spread out freely without money and without price.

To face these existing conditions the electric light, which is comparatively expensive, must have behind it the backing of nerve and courage and an unbounded faith in the good taste of the people of Pittsburgh, who, with its greater cost, have adopted it in preference to that of its mighty competitors—that light which not only illuminates but adorns their dwellings, their mercantile houses, and their public buildings.

Seven years ago the first Electric Lighting Company was started in Pittsburgh with 14 arc lights. It struggled along against the prejudice against time-honored usages for six years, at which time three hundred light. were burning where there had been ones Here a new era opened, and within the short space of eighteen months the electric lighting business increased to 350 arc and 20,000 incandescent lights, which now blaze in a constellation of glory, reflecting credit upon its progenitors. During the past six months we find that great progress has been made in cheapening the methods by which electric lighting is produced; this is noticeably the case in the arc lighting business.

The extension of arc lighting since our last meeting has been something marvelous, while even that has been outstripped by incandescent lighting, both by direct and alternating systems.

There are to-day in this country at least 3,000 isolated arc or incandescent plants and over 1,000 central stations. At our last annual meeting there were in operation in the United States, approximately, 125,000 arc lights. Since that time there have been installed and contracted for probably 50,000, bringing the present actual total within the neighborhood of 175,000 arc lights.

The number of incandescent lights at our last meeting was slightly over a million and a quarter. The installations and contracts made since that time are reported to foot up nearly half a million, bringing the present total to about one million seven hundred and fifty thousand, giving, it will be noticed, on the whole business, a proportion of about ten incandescent to one arc. These are statistics which exhibit extraordinary growth, and yet are conservatively estimated.

I beg again to urge upon the members of this association the necessity of intelligent and well directed efforts toward the more perfect construction of lines and installation of apparatus. While some fatal accidents have marred the record of the past six months, I am glad to say that they have been fewer in number and less chargeable to the danger of the system itself than have been similar casualties in any other calling that involves the use of power-driven machinery.

The attendance at this meeting is sufficient evidence of the success of this association. The secretary's report shows a membership of 168. By reference to the report of the treasurer we find that a fairly good financial showing is made, with a debt of only $98, and with $971 in the treasury to cover all expenses of the present fiscal year, we need have no fears on that score.

Considerable progress has been made by Arthur Steuart, chairman of the legal committee, toward bettering our condition in the patent office. This is a matter to which your attention will be strongly directed during the present convention, and I ask for it your calm and careful consideration. You will be called upon to decide whether or not further steps shall be taken in the direction already pursued. I am seriously of the opinion that, for the better protection of those engaged in the electric lighting, whose first investments depend largely upon the validity of their patents, we should, if it is possible to do so, prosecute to a successful conclusion a work so well begun by the legal committee.

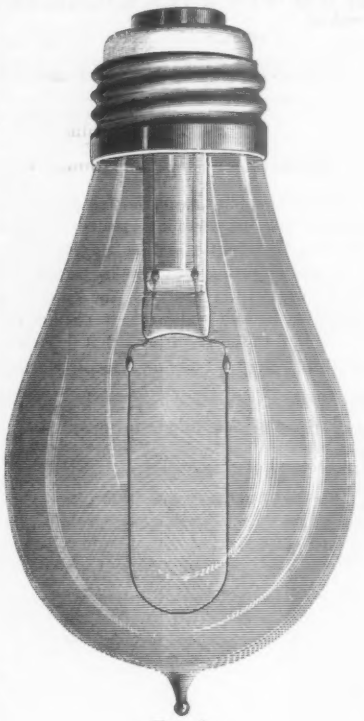

FIG. 3.

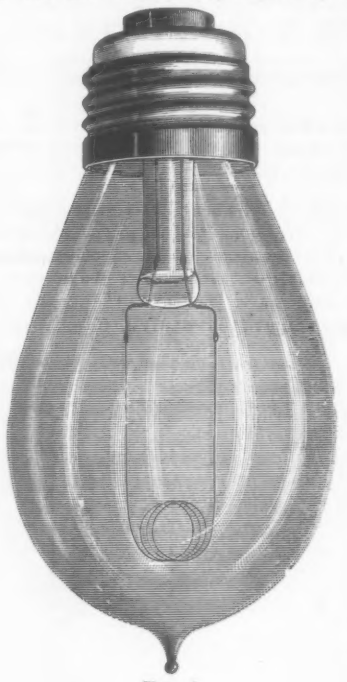

FIG. 4.

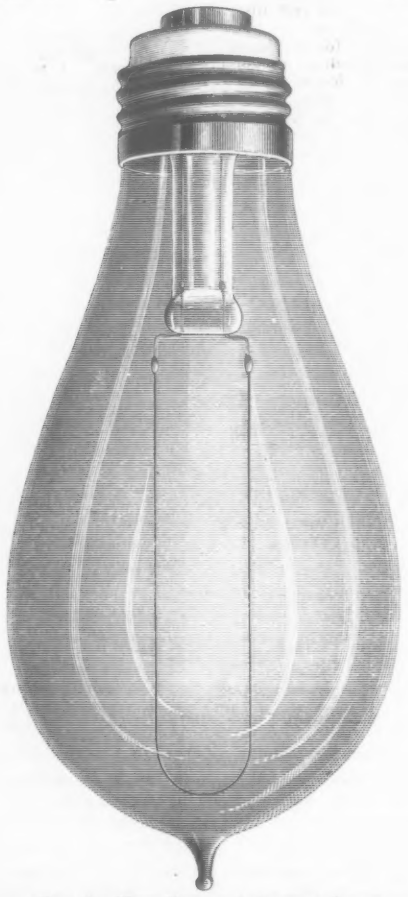

FIG. 1.—NEW EDISON ½ AMPERE LAMP.

Papers will be read as follows: On "The Practical Side of the Distribution of Alternating Currents from Central Stations," Mr. T. C. Smith, Pittsburgh; on "Underground Conduits for Arc Lights," Dr. W. W. Leggett and Mr. Jesse M. Smith, Detroit; on "Incandescent Lamps," Dr. Otto Moses, New York; Mr. A. L. Reineman, Pittsburgh; on "Electric Motors," Dr. G. A. Liebig, Baltimore; on "The Economic Value of Steam Pressure Records," Jas. B. Edson, M E., New York; on "Leather Belting, its Origin and Progress," Charles A. Schieren, New York; on "Independent Engines in Incandescent Stations," W. Lee Church, Pittsburgh; on "How Can We Protect our Watches from Magnetic Influences?" Philip Lange, Pittsburgh.

Permit me to congratulate the association upon the excellent work done by Dr. Duncan, chairman of the executive committee who had been so ably assisted by his colleagues, and who has shown his signal executive capacity by the excellent manner in which he has prepared for the prompt transaction of the business of the association, and for the comforts of its members.

I desire to call your attention to one or two points which reflect a great deal of credit upon the citizens of our own country, and perhaps, to put it mildly, negligence on the part of those abroad. Statistics show that in this country we have 178,000 arc lamps in service, and also a large number of incandescent lights. Now the question naturally arises, why should we have made such headway on this side of the Atlantic, and why should the business have been practically at a standstill on the other side? The answer may be given in two words—vicious legislation. If one absolutely inimical to progress had planned out an act of parliament which would have absolutely quenched electric lights in Great Britain and Europe he could not have better succeeded than those who framed that infamous act known as the Parliamentary Lighting Act, which has paralyzed that industry, has smothered invention in that direction, and which finds its only vent in the spleen which casts slurs upon those of us on this side of the Atlantic who have been diligently engaged in procuring this light which has been so popular amongst all classes of our people. A few years ago it was only the rich who could enjoy this luxury. To-day, it is brought to the door of the poor man's house, and within a year or two more it will be the popular light which will not only take the place of the illumination by gas, but will take the place of the coal oil lamp, and will be within the reach of every one who is capable of reading and who is desirous of using the electric light for that or any other purpose.

I now have the pleasure of introducing to you Major W. C. Moreland, who will offer you the privileges of the city of Pittsburgh.

MAJOR MORELAND addressed the convention as follows:

Mr. President and Gentlemen of the Convention: I cannot present myself in the shape of a bouquet, nor can I hope to receive your flattering encomiums by my personal appearance. I regret that your convention is held on election day, when all the bars are closed, excepting those to the hospitality of the people of Pittsburgh. I have been requested by the mayor of the city of Pittsburgh to give you a welcome to this city. To me it is a personal pleasure thus to speak—first, because I have a warm personal interest in all the men connected with the development of electricity in all its parts, and because in this convention sits a man who, forty years ago, was my master and my boss; taught me how to carry a telegraph line—how to make a connection; taught me something about a magnet, a little bit about an instrument, and asked me on one occasion to go—not very far from where we are sitting—to see whether the lines were not broken between two poles; told me how I could test whether or not the connection existed between those two poles, by putting the two ends of the wire to my tongue. I did it, gentlemen, and fell over the hill. (Laughter.) I sat opposite him when the first telegraphic communication between New York city and New Orleans ever passed over this part of the continent. I heard him say that he had carried the wires through the marshes of Louisiana, along through the whole of the South to Louisville; from Louisville to Cincinnati, from Cincinnati to Pittsburgh, and at Pittsburgh he stopped to see whether the Eastern connection was correct or not—my friend, David Brooks—the man who introduced electricity into the city of Pittsburgh, and made the first connection ever known in this country by wires connecting the extreme East and the extreme South. (Applause.)

I have, in addition to that, gentlemen, a personal pleasure in asking your attention to the industries of the city of Pittsburgh. If you have leisure to examine them they are worthy of your study, and we are glad that such a convention as this has assembled in our city, representing, as it does, not only experimental, but great brain power. You have solved the great problem that was in the mind of Benjamin Franklin, who claimed that electricity was at last to be subordinated to the uses of man. You have brought it to our homes, you have brought it to our industries, and who can tell where, with your industry, your brain, your perseverance, it may at last land? It has now become, not a commodity, but a pleasure, at our homes and firesides; and after a while it may be that we of to-day may be laughed at as being in the very incipiency of the power of electricity.

Gentlemen, I have a personal pleasure in meeting you, not only because an old electrician myself—that is to say, a novice in electricity—but one who sympathizes with the progress made during the last thirty years of time, and, secondly, because you are right in the place where, of all other places, we want electricity practically applied. I know nothing about your purposes; nothing about the progress your society has made; but, in the name of the city of Pittsburgh, as the representative of its mayor, I bid you a most hearty welcome, and am glad to say to you that, after the election is over to-day, every place will be open for the convention. (Applause.)

THE PRESIDENT: I now declare this convention open for the transaction of business. The first business in order will be the reading of correspondence.

The secretary read a letter from Mr. G. S. Bowen, expressing his regret at being unable to attend the convention, also a letter from Mr. F. G. Osborn, Chairman of the Committee on Progress of the Engineers Society of Western Pennsylvania, inviting the members of the association to attend a

meeting of that society at 8 o'clock in the evening.

On motion of Mr. Duncan it was agreed that the invitation be accepted and that the association attend the meeting of the Engineers' Society.

MR. DUNCAN: I move further, sir, that an invitation be extended to the Engineers' Society of Western Philadelphia to attend the sessions of this convention at their convenience, and participate, if they so desire, in the discussion that may take place. The motion was carried.

A letter was read from the Allegheny County Light Company, inviting the members to visit the station of that company. On motion the invitation was accepted. A similar invitation from the Westinghouse Machine Company was read and accepted.

A telegram was read from Mr. H. C. Davis, President of the Electric Club of New York, tendering to the association the use of the club house in the event of their holding the next convention in the city of New York.

On motion of Mr. De Camp the communication was referred to the committee to be appointed to name the place for the next meeting of the association.

A letter was read, signed by several Westinghouse sub-companies, enclosing a contribution by those companies of $1,150.00 "to encourage the best interests of the association."

The communication was received with applause, and, on motion, accepted, with the thanks of the convention.

The report of the secretary and treasurer was read and accepted.

The report of the chairman of the executive committee was read by Mr. Duncan, and on motion of Mr. H. W. Pond the action of the executive committee was approved.

The recommendation of the executive committee that delinquent members shall be notified at once that they are in arrears, and that they will be dropped from the rolls after the expiration of thirty days if their dues are not paid, was, on motion, adopted.

MR. DUNCAN: I submitted in writing, as provided by the constitution, and left with the secretary, an amendment to the constitution in regard to the question of dues. The dues at the present time, are an initation fee of $10 and yearly dues of $10. It is very evident to the members of this association that for some time past the association has omitted to have its reports printed, but the association has not had the funds to properly proceed with that work, and to print those as they should be printed in pamphlet form, and it is only at this meeting that our funds are in such shape that we could possibly proceed with the work. The matter had given rise to considerable debate and discussion, and in order that it might be brought properly before the association at the right time, I submit the following amendment to articles of the constitution: "That the yearly dues of the association shall be $20." I submit that as an amendment to articles of the constitution, and ask that it may lie over for consideration until to-morrow morning to be made the special order of business at our opening meeting to-morrow. Motion carried.

THE PRESIDENT: In pursuance of this provision of the constitution, I will appoint as the committee on this amendment, Mr. Duncan, Dr. Moses, and Mr. Weeks.

MR. DUNCAN: Mr. Chairman, I desire to make the following motion, which was unanimously recommended by the executive committee—that Prof. George Forbes, of London, England, be elected an honorary member of this association. Carried.

MR. LYNCH: I should like to make a motion for the appointment of a committee of five for the nomination of officers for the ensuing year, said committee to also make a recommendation to the association for the next place of meeting; the committee to be appointed by the chair. Carried.

Prof. Thomson's paper was read by Mr. E W. Rice, jr.

THE PRESIDENT: The paper is now before you for discussion.

DR. MOSES: I have been informed that Prof. Thomson being absent, as the second on the list, the president requests that I shall speak to the resolution. I feel like quoting a passage that I think will reverberate in all your hearts: "The boy stood on the burning deck, whence all but he had fled," I do not see another member of that committee. (Laughter.) When that committee was appointed, the president did me the honor to ask me to serve as the chairman, but for two very good reasons I declined. The first was—which he recognized when I declared it, and no doubt the convention did—that there were others more competent than myself to fill that place. Another reason was that I intended to return to Europe on some business that I had left uncompleted, and I did not know how long my business would detain me. In fact I was right, because I have but just returned. Within the last three days I received a communication from the chairman of the committee asking me for my opinion of the report which has just been read—asking my approval or disapproval. I gave neither the one or the other, as the time was too short for him to receive my reply, and I expected to answer him at the convention in person. As he is not here and has kindly submitted to the convention a paper which embodies his own views on the subject, I believe that I should speak for the committee, since they appear derelict in their duty. It must be borne in mind that a committee of solid men was appointed before this one was formed who did some preparatory work, but who declined to proceed further in the investigation without some money being put in their hands for experiments. But the president of our association, with his usual intuition, appointed a committee composed of men that had laboratories at their command. If my memory serves me, that committee consisted of Prof. Thomson—we all know how admirably fitted up his laboratory is—of Prof. Duncan of Johns Hopkin's University—we know how much care and time Prof. Rowland and himself have spent on that laboratory—Mr. Hamilton, of the Western Union, who has entire charge of the electrical outfit of the Western Union Company; Mr. Lockwood of the Bell Telephone Company, known to you all by his writings and his active investigations in the direction of telephony; Dr. Waldo, who has had several university laboratories under his command, it and Mr. Shellenberger, of the Westinghouse Electric Lighting Company. All of those gentlemen, as you know, are fully equipped, and although he added me as a kind of tail to the kite, I suppose, out of compliment. However, I gave my reason, and he accepted it and put me as second on the committee—perhaps because I had refused the chairmanship. But I did not intend to take any of the work out of the hands of those gentlemen, because I knew that all the different branches of installation would be properly represented by them. There was the telephone insulation, telegraphic insulation, high current electrical insulation—general scientific treatment of the subject, so that the committee was formed for the purpose of getting an exhaustive report. Now the reasons that have been advanced by the chairman of the committee are very valid in some respects; yet, as I only received a communication but two days before the meeting of the convention, asking my opinion on the subject, I am led to believe, though I have no absolute reason for saying so, that other members of the committee may be in exactly the same position as myself. They may not have received sufficient notice to enable them to give the report the attention it deserves. I do not feel as if that committee should be discharged. They are all good men and true. I am speaking for the others, I know myself to be true; whether I am good in that direction might be found out. I would suggest that the chair should be invited to reappoint them, and to make any one of them the spokesman—not so much for furnishing a report, as is usually the case with chairmen of committees, but simply to be a head. There must be a beginning. We cannot make round robins in committees, but every member of that committee is able to do good work, and I think that the convention would be very much benefited by getting their experience, and I hope that the next report of this convention, which will no doubt be brought out in excellent style by the secretary, supplemented by the cash assistance that we received to day, which will enable us to publish a fine report, will be furnished with a report on insulation that will be of benefit to this convention, and that will be somewhat of an honor to American elocutionists for its thoroughness and fullness, and I hope that it may be a type for future reports that may be submitted to this convention.

MR. DE CAMP: I agree with Dr. Moses in thinking that that committee should be continued. There is a great deal in it for discussion and which should be brought out in the course of some paper which could be presented to the association before the close of this meeting, which the members of this committee will have the benefit of, I suppose, when the reports of the association are published. There is a great deal in that report which will come under the head of our underground discussions, as well as the report on our overhead lines. I will therefore move at the close of this discussion, if there is to be any on this particular report, that the committee be continued as it is, to report the next meeting of the association.

The motion was seconded by Mr. Lynch and carried.

MR. LEGGETT: I wish to make simply a suggestion which occurred to me as this paper was read. It is doubtless a suggestion which has arisen in the minds of members of this committee, but it is barely possible that it may not have. That is the effect upon a lead-covered cable, of a short kink in the cable, or of a dent in the lead—the compression of the insulation whereby the insulation is rendered a better conductor, and so at that point there is a better opportunity for the current to leak out. I suppose that has occurred again and again to members of the committee. In the matter of insulation it seems to me that would be a good point to consider. The same, of course, should be considered in respect to other insulations beside the lead covering. There is one other point that occurred to my mind in the reading of the report that possibly might properly come under the consideration of some other paper. I notice Prof. Thomson refers to the high potential of the alternating current—whether that matter has been considered as to whether it is as high a potential as is reckoned—as 1,000 volts—whether or not the alternation of the current, whereby at one instant there is no current, at the next instant a current in one direction, and the next instant no current, and then a current in the opposite direction—whether or not the potential, instead of being 1,000 volts, is not 500 volts—I do not refer to the potential, I refer more particularly to the action of the insulation—whether or not the conductivity of the insulation is not required to carry a current of 500 volts rather than 1,000—whether it is not an average between no current and full current, and whether that does not account for the fact, which I understand to be a fact, that with the Westinghouse alternating current they have put underground a number of their lead-covered conductors with good results—whether the result is not due to the fact that there is less required of the insulation.

MR. RICE: If I am allowed to answer Dr. Leggett on that point I would say it is just about the other way. The potential that the insulator has to stand on a thousand volt alternating circuit is two thousand volts, just about double what would be on a direct current That is occasioned by the wave going up for two thousand volts and then going down to zero. When you say two thousand volts it means an average of one thousand volts, and for a certain period of time that has to go to two thousand volts, making an average of one thousand. Perhaps the reason we do not have any more current with the alternating current than the direct is that there is no active kick to speak of on a disruption of the line; whereas with a direct current there is quite a kick.

DR. MOSES: I am glad that Mr. Rice has spoken on the question of the excess of potential above the general average, and also that Mr. Leggett has called attention to the fact. It is a mere hypothesis that the potential rises to two thousand volts, because in measuring those currents Prof. Rice will bear me out that he has never seen indications with an alternating current of a thousand volts potential. It therefore simply becomes a hypothesis. Because the current goes to zero and rises from zero it is supposed that the average must be one thousand, and that the extremes should be zero and one thousand. But there is no evidence in that fact whatever It is a surmise, and it would be a very important thing for this committee to bear that in mind, and the secretary in making notes of these things would oblige us by sending to the chairman of the committee these points, so that they may be worked up. They are very important to be known. I myself am pleased to hear that suggestion of Mr. Leggett, that the condensation of a lead-covered cable may act somewhat in the light of points in static discharge.

MR. LEGGETT: My point on that went a little further—the compression of the insulation itself. For instance, carbon chips will form a very excellent resistance for the passage of the electric current, yet if you compress those carbon chips they become a good conductor. The question is whether the compression of the insulation by the kink in the wire, or by the bend in the wire, does not serve at that point to make the insulation a better conductor.

DR. MOSES: I would say that perhaps the compression at that point will be extended as a pressure in the liquid, because these insulating materials are expanded and extended uniformly throughout the mass in the neighborhood of the compressed point; so that the pressure will be distributed very evenly throughout. In the telephone, for instance, when the carbon button is compressed, it is not impossible that the compression extends throughout the whole mass, and the multiplicity of points brought into varying contact produces the effects stated; so that the compression may thus extend through the whole mass. I think unless there is an induction taking place, each reversal of the current, that I first suggested, that the point of pressure might be the one most dangerous, and the one which should be very carefully looked after.

MR. DE CAMP: I cannot claim any practical or theoretical knowledge as to this alternating current. I will simply put myself in the position of an asker of questions. I have generally understood that one of the difficulties in maintaining perfect insulation with direct currents is in the obtaining of insulation to cover a given number of volts, and to provide against what I understand is the reactionary current arising from various causes. Dr. Moses states, and therein agrees with Prof. Rice, that the alternating current runs from zero to 2,000 volts.

THE PRESIDENT: Mr. Rice stated that the current ran from zero to 2,000 volts, but Dr. Moses stated that was a hypothesis, and that there was no proof of it.

MR. DE CAMP: It is a case of "not proven;" but do we stand convicted until it is proven?

THE PRESIDENT: The first proof will be on the part of Dr. Moses.

DR. MOSES: We stand as to that as Faraday says we always should stand in the face of an hypothesis, with a suspended judgment.

MR. DE CAMP: We shall have to hold that judgment in suspension until it has been demonstrated by every manager of electric lights that slight intermissions of currents are pretty sure to be developed by any reactionary current which is, intentionally or otherwise, created on that circuit. I think that that is correct. That of course is not only liable, but certain to be developed at particular locations, and it is likely to create others. It just occurred to me that if this alternating current is of that nature, that it is a constantly reactionary current—continually so—and hence my conclusion would be that the difficulty of insulating against that kind of current would be greater than that of insulating against a constant current.

MR PRESIDENT: Will you permit me to interrupt you a moment? A paper has been prepared by Mr. Shellenberger, entitled "The Energy of Alternating Currents" This paper will be read to-morrow; and this discussion will perhaps then be more appropriate than it is now.

MR. EUSTIS: With regard to underground wires I wish to mention a little result that came to my notice some time since, which may be of some use to the convention. In Prof. Thomson's paper he states that, after the cables are once laid, they are then not liable to be disturbed, owing to the mechanical covering outside. But I know of one particular case in which the insulating wires were laid in a conduit, by a railroad track, in a box about six inches square. Three or four wires were laid in that loosely. Every time it rained the water from the side of the tracks washed more or less through this conduit, and carried with it, I presume, some sand. At all events, after the wires had been laid there about two years the insulation was found to be destroyed, and on drawing the cables out it was found to be due almost entirely, as far as outside appearance went, to the purely mechanical injury. The only explanation that I can see for that was the fact that, as the heavy trains went over this conduit, they compressed the ground, and the cables being laid, as it were, suspended, owing to its own stiffness, the two wires slipped by each other and gradually chafed the face of the two wires, one upon the other, and cut the insulation through. If any one has had a similar experience I think it would be a benefit to the association if he would state it.

DR. MOSES: I would like to ask if those wires were suspended or laid on the board.

MR. EUSTIS: They were simply laid loose.

DR. MOSES: Not only holding their own weight?

MR. EUSTIS: They were thrown into this box loosely, and they were undoubtedly full of kinks. My idea is that, as the box gave from the weight of the trains, the wire being loose in the box, because of its own stiffness, would spring against one another, the two wires bending differently.

DR. MOSES: I would like to mention in connection with that, some curious facts that came to my attention yesterday, and which were told to me while several members of the committee were being hospitably entertained by the gentlemen here. We were visiting the Westinghouse works, and saw a very large trip hammer, and when we were up in the cozy office, we could hear that rebounding and shaking the foundations with a force that was quite terrific. One of the gentlemen cited a fact, and a very interesting one it is, to show how, under repeated blows, material may be projected through a mass of other material. These slight vibrations might very easily cause the abrasion of the outer covering of two wires, if, when the trip hammer falls upon an anvil, an iron scale gets between that and the anvil, the iron scale can be forced through the body of the anvil and come out at the lower side, as is said to be the experience of many iron workers in Pittsburgh. It is a very interesting fact. I knew that, if a ball be put upon a solid barrel of resin, it will, after a while, be found at the bottom—its weight acting upon the viscous mass, causing it gradually to descend to it. And, as for instance, the impression of certain strong intellects may be felt over very large bodies of men, by persistent action—as I know occurred in one very particular case that I will not cite. But that is a very interesting fact. It also recalls to my mind a fact, which I had the pleasure of stating at the last meeting of the Association that, among the cables of the Brooklyn bridge, there are some hard-drawn wires that are always being thought of by the constructors of that bridge, because they are afraid that with the gradual stretching of the cable those hard-drawn wires will be less effective than the softer ones, and ultimately, so great a strain will come upon them, that they will be ruptured. So that the very small action, long continued, may produce just the results that he speaks of.

MR. EUSTIS: With regard to the matter of

the scale going through the anvil, I will say that in this particular case the abrasion takes place for lengths of about six inches, or twelve inches, at different places throughout the whole length of the wire, and ex ending a distance of something like fifty feet. There would be places eight inches in length, where the outside covering was completely chafed through, evidently from some change of that kind. What it is caused by we do not know. In other places the insulation was perfectly intact.

MR. BROOKS: This slight jar or concussion can only be seen after a time. This matter was brought to my notice the other day by the Pennsylvania Railroad Company. They had laid three cables in a wooden box, along their railroad track. The boxes are four inches square, and fastened or closed; but it was found after a while that the cables began to give way. They opened the boxes, and they found that where they were laid on the bottom board of the box, the cables had worked, by reason of this jar, about half way through the board, and it had taken the covering off, greatly to their surprise, so that the insulation was interrupted. I have heard that in London, where they run the pipes on the overhead ways, even on those made of bricks, or of solid masonry, this continued jar will in time begin to affect them, so that it is well, when anything of that kind is laid, to have it away from anything like concussion, although the concussion may be but small in amount.

MR. SPERRY: Inasmuch as we have Mr. Sunny with us, and he has a large experience in handling high potential direct currents underground, and as this matter of insulation is a very important matter, and anybody who can give us light upon it should be heard, I would suggest that he give us the benefit of his experience.

MR. SUNNY: My connection with the electric light business has only been for a short period; and I do not know that I am very much acquainted with it to speak on the subject. We have had some experience with underground cables; and I have made some memoranda indicating the results of our experience which I intend to present when the discussion of underground cables comes up, as I understand it will in a day or two. I would like to state, however, in reply to Mr. Leggett's question as to the effect of a dent in a lead cable, what the effects are upon insulation. We have to-day a large number of burn outs in our lead-covered cables; and I have been investigating a few of them; and I find as a rule the cable has burned out at a point where the surface was perfectly true, and where there were no indications of mechanical injury. On the other hand, in pulling out cables which have been destroyed, we have found portions of them where the mechanical injuries have been so great as to completely clean the lead off the insulation, leaving the lead bared. There was no indication, at the point where the lead was bared off, that any leak of the current occurred at that point. The facts that I have embodied in this short report are at the pleasure of the convention.

MR. LEGGETT: I would like to inquire, in those cases where a leak occurs, whether that leak is apt to occur at a point where the wire crosses above, or in the vicinity of steam pipes, or any other hot pipes, is one which would be caused simply by a difference in the expansion of the copper and lead, whereby one wire would be caused to force itself against the other, or compress the insulation between itself and the other.

THE PRESIDENT: The next paper to be read is one written by Mr. Lange. As he is not here I would like Mr. Martin to read the paper of Mr. Lange.

Discussion followed on Mr. Lange's paper, as follows:

DR. MOSES: That is an exceedingly interesting and valuable paper, and one which I think will be very much appreciated by the representatives of several of the largest watch companies in the world, who are now present. It was at the last meeting of the Association referred to as a very important matter; and we are glad to know that Mr. Lange has been able to give us a means of overcoming the difficulty which is at once so thorough, so simple and so ingenious. I had intended to call attention to a fact which he has dilated upon. I have not read his report, but I knew that he was quite competent to handle the subject. The other day I had occasion to speak to a friend about an experiment that I had tried on the previous evening. I was in my bedroom, and took my watch off to place it upon the bureau, where there was a little compass belonging to one of my children; and I thought to myself that I would see whether the watch, which was said to be protected by a magnetic shield, would affect the magnet. Fortunately for the experiment, as I approached the watch to one of the poles it was repelled, and thus absolutely proved that there was a permanent polarity somewhere in my watch. Had it been simply a mass of iron that acted upon the poles of the compass magnet it would have attracted it to either pole; but after repelling the first pole I found it was repelled, which was proof to me of the magnetic polarity of some part of my watch. This watch of mine has given me a great deal of concern. It was presented to me on my 21st birthday, and I have carried it as a souvenir on account of its having made me miss several important engagements; and I will do anything in the world to demagnetize it. In 1878, while at the Paris Exposition, I mentioned it to Mr. Varley, and he very kindly took it to an Edison dynamo, and turned it round in a way to reverse the polarity, which is equivalent to alternating the current, until he got away some distance from it; but still he did not demagnetize the watch. I could not understand the reason of this, but explained it to myself in this way. That there was a certain amount of magnetism in my watch, every part of it being of steel, and that certain of these parts were lying parallel to the lines of force at a given time, and that they attracted the magnetism and acted upon the hair-spring balance-wheel. But to continue the statement of my experiment: I mentioned that to one of my intelligent friends in New York, and he said, "Show me that, because I believe that my watch is taken in the same way. It stopped suddenly last night, and this morning went on again." I thought it a very important matter if we could manage to get our timepieces to going regularly; and it is quite evident, because of the reasons advanced in the paper which has been read, that this should be so. So I said, "Let us see what is the reason." Said he, "I opened the case some time ago, to see what was the matter. I found that the watch had stopped, and in order to see what was in the watch to make it stop, I opened it with my pocket-knife, and perhaps my knife was magnetic." Said I, "Let us try it." So we took a needle, and floated it on a cork on water—that being a delicate compass needle with which to test for magnetism. He applied his penknife to it, but it did not work at all. So I said: "Who made your knife?" He said: "Rodgers." Said I, "I guess it is a pewter knife." "No" said he, "it is a steel knife." I looked at it, and sure enough there was Rodgers marks upon it. I thought that I would show him how the needle would whirl around if a magnet was made to approach it, and so I took my knife which I knew to have been made magnetic by one of my children a short time before, and I brought that knife near the needle, but it did not budge. Said he, "I guess yours is a pewter knife." I said, "Not at all; it is a Rodgers knife, too." I thought to myself, how is this? I recollected that only the day before I had been between the poles of an alternating current machine. I had not tripped over it, nor was I thrown fifteen feet away, as a gentleman is reported as saying; but I was nearly in the neighborhood of it, and probably my knife had been demagnetized in that way. The observations made by Mr. Lange, in his paper, more and more impress upon me the absolutely essential character of alternating currents for all distribution of electricity where we have to depend for life, or the safety of property, upon the compass needle. I think that that paper points to the abandonment of the continuous current distribution of electricity on board steamships. That is a very broad saying, but I think it will be proven, or supported by the facts that he has mentioned, and that as soon as the attention of owners of steam-ship lines are called to it, they will investigate the matter and verify the statement by experiments, and that the result will be a change of the continuous current machines into machines producing alternating currents. That is a most important thing, and may be the means of saving many lives. I have had opportunity recently to see something of the carelessness of the officers and sailors on shipboard in respect to handling the electric light wires when they are being moved out of the way. They do not seem to know what they are, or what they are doing. They do not consider the action of the currents upon the magnets that are entered there, or that the captain in his walks down the decks is relying upon the magnets for the direction of the ship. So that it is a most important thing that we should get rid of the possibility of the reverses of the polarities of compasses, or of the action of currents upon them at given times—in times of danger—and its effect upon the direction of the ship. So I think that the paper which has been read will prove one of the most instructive to be found in our annual proceedings.

MR. SMITH: I would like to ask Dr. Moses what would be the effect upon the ship of demagnetizing the compass. What mischief would it do?

DR. MOSES: The result would be that the ship would float around indefinitely; and when they were thinking that they were going to do most they would find the needle following the movement of the ship, and going round as any needle would if you blow upon it. If, for instance, you attempt to float a needle upon water, and come close to it, you will find it darting off like bacteria, in all directions. It takes so little to disturb it when floating on water that so slight a cause as the breath, or the jar of the earth by closing a door, will move it.

MR. KERR: I might mention the fact that there are about eight needles in a large ship's compass, and it would be hard to demagnetize them all at once.

MR. LAW: I quite agree with Mr. Lange in his experiments, and I may state that I have been considerably troubled with my watch. It has a shield on it, and I will guarantee that if placed side by side with any watch in the room it will interfere with that watch's movement. I mean, any watch not properly protected. I have had considerable experience since the time of the Electrical Exhibition in Philadelphia. While there I had demagnetized hundreds of watches by the old process of spinning them between the poles of the dynamo; but I had to be very careful in doing that not to do it as a man did who came into the station one night, and said, "I would like to demagnetize my watch;" and he held it out to the dynamo, and soon after he had to pick it up all around the room. I went through that precise experiment last week with Prof Houston; and the remarks which he made I wish to call to the attention of those who are investigating this subject. I will not state them in detail, but they refer to the old experiment of turning a copper disk between the poles of an electro magnetic machine. That copper disk will produce currents which are called I believe, Barlow's wheel. The supposition was, that although the balance wheel of the watch was made of purely non-magnetic material, still if placed between the poles of the dynamo its influence would affect the balance-wheel the same as it did the Barlow's wheel. The first experiment was to place the watch in the safe at the works for three weeks. I was a watch manufactured by one of our largest watch-making concerns in the country; and it was purely non-magnetic. The action was perfect. It was timed every day by a reputable watch-maker. This watch was placed on the poles of a 20 light Weston machine, and remained there for five minutes, without any effect. My own watch was placed by the side of it and instantly stopped. Then the watch was placed between the poles of a Amo-Hockhausen dynamo—a thirty light machine. The armature was taken out, and the watch braced up by wooden blocks, so as to come right between the poles of the magnet, and directly in the strongest line of the force. We put that dynamo in a Daft circuit; the watch was placed in and allowed to remain there one hour. It lost fifteen seconds during the time. But understand, gentlemen, that the influence of the dynamo in this case was far more powerful than it would ever be called upon to sustain in ordinary use. I wish to call the attention of those experimenting in that direction, with a view of ascertaining if they have discovered any action on the balance-wheel, even though it be non magnetic, upon this old principle of Barlow's.

DR. MOSES: I would like to call attention to the first experiment ever tried, and the one which led to the discovery upon which Faraday has built that immortal superstructure. Faraday found that the needle of his compass, a short needle, oscillated too quickly. Thereupon he had a heavy brass plate under it. The needle diminished its oscillations about one half in a given time, showing the influence of a solid mass of metal upon it—the result being as afterwards proven by Faraday, the introduction of a current in a copper disk under which it would be acted upon by the current circulating around the magnet; so that no mass of metal oscillating in a magnetic field will retain permanently the same number of oscillations per second that it had before it came into that field.

MR. GARRATT: I confess that Dr. Moses has somewhat frightened me; and I think that perhaps any one who has occasion to go down to the sea in ships, and to do business in the great waters, might well feel alarmed if he were to assume that the great vessels, which are built of iron, which cross the ocean with their freight of thousands of lives and millions of dollars of worth of property stood in any very great danger by reason of the electrical appliances which they now have. I know nothing whatever from personal experience about the effect of dynamos and currents, and more especially the induced effect of currents upon navigation; but I am informed by a friend, an engineer of experience, and in whom I have confidence, that in some of the great ships which are covered with a perfect ramification of wires, there has never been found exerted any influence whatever upon the compasses by the electric plant which lights the ship, and did a part of the mechanical work upon it. In saying that, I do not wish in any way to reflect upon what Dr. Moses says in regard to the value of using alternating currents where they can be so used on board ship, or in other places where we must rely upon the magnetic needle; but it does not seem to me wise that it should go out of this convention that the present apparatus in use upon steamships is one of very great danger. On board the steamship Trenton the curves of that ship and its magnet were worked out almost every day for a time after the electrical appliances were put on board; but no variation of the compass needle, or of the magnetism of the ship itself, or of any part of it, resulted, so far as the engineers, who very carefully investigated the matter, were able to discover, resulting from the dynamo plant which the ship carried. I want to again say that I do not intend that statement as a criticism or reflection upon what we all must recognize to be the very valuable remarks made by Dr. Moses; only I want to suggest that we are not in any great danger, the next time we want to cross the Atlantic, of fetching somewhere near Sandy Hook after we have started for Liverpool, simply because we have a dynamo on board the ship.

MR. SPERRY: I would like to ask the last speaker if it is not a fact that those compasses are provided with heavy masses of metal, thus forming a magnetic shield around the compass.

MR. GARRATT: I would be most happy to inform the gentleman, but he must remember that I put a saving clause in my remarks,—and that was that I knew nothing whatever about the subject upon which I was speaking.

THE PRESIDENT: In order to reply to Mr. Sperry's question, I will ask Mr. Colvin, who was an officer on board the Trenton, to state what the fact is.

MR. COLVIN: On most ships the compasses are surrounded by a mass of metal which acts as a shield. In the case of the Trenton (and I was aboard of her for some period) I had occasion to work those deviations of currents, and they were worked out on this side as they were in the Mediterranean. We would swing ship and take the bearing of the sun on every point, and every half point sometimes, with the dynamo going and then with the dynamo not going; with certain lights in and certain lights out; with lights going in the pilot house, and lights not going in the pilot house. We had a torpedo apparatus there, of which I had charge; and the currents of that did not affect the compass at all. The ship's compass is composed of a number of needles of steel on the under side of the cargo; and I never knew any variation in those curves that would amount to anything. The captain of the ship does not walk about the ship not knowing what his compass is doing. He knows more about that compass than he does of his own mind; and it is worked out every morning; and every morning the captain takes a sight for the longitude, and by that corrects any deviation of the compass; and so he his pretty safe.

DR. MOSES: This is a very interesting subject for the convention to dispute over; but I may say that I happened to be on board a French ship when there was a fire started, which alarmed all the passengers and officers; and although we were but a short distance from the harbor we all felt very nervous for about an hour. One of the wires was torn out on deck. Now I would like to ask our friend Colvin whether, if a wire carrying the entire current from the dynamo that was competent to supply five hundred 16-candle Edison lamps, was in that performance brought near to any one of the compasses upon which the captain depended, what would be the effect of that upon the compass—even though it might be surrounded by a very large mass of copper. Does he think that it would have no effect upon the deviation of the vessel from her course?

MR. COLVIN: In the case that he refers to the effect would have been that the quartermaster forward and the quartermaster aft would notice that their compasses differed, and knowing that there was a difference the aft quartermaster would go forward and would steer by the forward compass.

DR. MOSES: I would like, also, to insert a saving clause. I said that the entire crew, captain, passengers and all, were in the highest state of excitement from the fire that was on board ship. We know some of the difficulties that would arise under those circumstances. Is it likely that there would be at such a time any comparison of the accuracy of the compasses?

MR. COLVIN: On a properly constructed ship—I do not know how it is in the merchant service, for there they sometimes save a good deal of money by not employing competent people—but in the naval service there are usually three people looking at the compasses at once, the signal quartermaster and two assistant quartermasters.

As to your objection, I will state that in the vessels on which I have been there has never been any spar deck wiring on the upper deck; it has been done with battens under the spar deck, and by the regulations of the department the compasses are put so far from any vertical line, and so far from a horizontal line; and the compass upon which they rely is usually some distance above the deck. All the other compasses could be lost or broken, and there would still be no danger on a properly equipped ship, that that particular compass would vary so materially as to produce any disastrous effects. I am speaking now of the naval service; I know that sometimes in the merchant service things are perhaps carelessly or ignorantly done. Your suggestion is a very valuable one—about alternating currents, and one which I would take pleasure in communicating to the department, although I am not now connected with the service.

The President appointed as the committee to nominate officers for the ensuing year, and

to name the place for holding the next meeting of the association, the following: Eugene T. Lynch, Jr., R. R Weeks, Frank Ridlon, H. D. Stanley, and A. V. Garratt.

MR. D NCAN: In view of our acceptance of the invitation to attend the meeting of the Engineers' Society at eight o'clock this evening, and as a further fact that our committees are to have a meeting this afternoon, I move that the association now adjourn until 10 o'clock to-morrow morning as I think we shall have done a pretty fair day's work.

The association then adjourned to Wednesday, February 22d, 1888, at 10 A. M.

SECOND DAY.

WEDNESDAY FORENOON.

The convention assembled at 10 o'clock. One of the most important things presented the convention was the report of the Legal Committee, by Mr Arther Steuart chairman, in an able address. In this he set forth the difficulties which stand in the way of reform and the methods which the committee has employed to overcome them. An animated discussion followed the reading of this report and was taken part in by several of the leading members of the association.

Mr. W. W. Leggett, of Detroit, in an elaborate address, opposed the position taken by the committee, and presented a resolution that the whole matter be laid upon the table, arguing that although some reform in the patent laws might be necessary, yet it was entirely out of place for the association to attempt to do this work, in which he believed its members were not particularly interested As a further argument he reminded the association that early in the seventies fully $100,000 was spent in a systematic attempt to modify the present patent system.

This was ably replied to by Mr. Steuart, who showed that the attempt above referred to was instigated in the interests of an organization of patent infringers, whose sole aim was to undo the present protection offered to inventors by the patent office.

A strong argument was made by the president, Mr. Morrison, who left the chair for that purpose, in reply to Mr. Leggett's statement that the patent office was in satisfactory condition.

Dr. Otto A. Moses and Mr. Garratt both spoke in support of Mr. Steuart's position. Dr. A. F. Mason also spoke in favor.

The question finally being called for it was voted to continue the present committee, to act without recompense from the association

Mr. Chas. Schieren, of New York, then read a paper on the Leather Belting, which we will publish next week. It was discussed by M. D. Law, T. C. Smith, E. W. Rice, jr., and Dr. Otto. A. Moses, all speaking favorably of the new link belt.

Adjourned to 3 P. M.

WEDNESDAY AFTERNOON.

The convention assembled at two o'clock, vice-president Weeks in the chair.

The first paper was by G. A. Liebig, which appears elsewhere. This was followed by a general discussion.

Prof. A. Reckenzaun, of England, spoke to the question from a practical standpoint, stating that elaborate formulas like those presented by the speaker were hardly to be found suitable for practical men. He suggested that the formulas of Gilbert Kapp, as given in his book on the electrical transmission of energy, would be far more applicable for the purposes under consideration.

Mr. Wm. Lee Church's valuable paper, which we publish elsewhere, was attentively listened to and applauded.

Mr. J. B. Edson, of New York, then read his paper on Recording Gauges, which we will publish next week.

Discussion on Mr. Church's paper followed, and was earnestly participated in by a great many of the delegates

Mr Jesse M Smith though Mr. Church, should be congratulated on the broad plane which he had kept his paper, as it could apply to any one of a number of high-speed engines. Thought high-speed engines not quite as economical of fuel as low-speed engines.

Mr. T. C. Smith called attention to the fact that Mr. Church's paper referred to high-speed engines for incandescent stations, and not for arc.

Mr. E. W. Rice, jr., said every one would agree to the subdivision of power, broadly stated.

Mr. Church thought the question could be satisfactorily settled by taking the practical results as shown in the stations.

Mr. Alex. Wright presented some figures taken from his station at Springfield, Mass.

The convention adjourned to 10.30 A. M., Thursday.

THURSDAY'S PROCEEDINGS.

The convention assembled at 10.30, Pres. J. F. Morrison presiding.

An amendment to the constitution was referred to a committee composed of Messrs. Leggett, Weeks, and Duncan.

Mr. T. Carpenter Smith, of the Westinghouse Company, extended an invitation to the association to witness the lighting of standpipes by natural gas at 7 P. M, which was accepted. The resignation of E. G. Acheson from Committee on Insulation was accepted. Mr. T. C Smith then proceeded to read the paper on the "Practical Side of the Alternating System," which was followed by a paper relating to the same subject by O. B. Shallenberger. Jesse M. Smith and W. W. Leggett also read papers on underground work. The above papers will appear in our next edition with the discussion which followed.

Mr. O. B. Shallenberger, electrician of the Westinghouse Electrical Company, read a paper discussing the measurement of energy of an alternating current by any known direct reading potential and current instruments. He maintained that no reliable results can be obtained by the use of voltmeters and ammeters and multiplying the readings. He first endeavored to show in theory why such a method must give fallacious results, very misleading to plant owners who desire to ascertain their output at times. Next, by a series of very graphic and instructive diagrams, Mr. Shallenberger carried his theory towards demonstration, and related the data of some elaborate experiments made to test the theory and determine its truth or falsity, finally arriving at the conclusion that his theory is correct. He was listened to with great attention, and the paper excited much discussion among the members.

The remarks of Prof. Forbes, who spoke at length on the underground question, will be found in a later issue.

After further discussion of the papers read, ballot for officers for the ensuing year was taken, with the following result:

PRESIDENT—S. A. Duncan, Allegheny City Light Company.

FIRST VICE-PRESIDENT—E. R. Weeks, Kansas City Electric Light Company.

SECOND VICE-PRESIDENT—A. J. De Camp, Brush Electric Light Company, of Philadelphia.

EXECUTIVE COMMITTEE—Otto A. Moses, Chairman; J. F. Morrison, E. T. Lynch, jr., Frank Ridlon, W. L. Strong, T. C. Smith, E. F. Peck.

E. T. Lynch, jr., E. R. Weeks, Frank Ridlon, H D Stanley, A. V. Garratt, committee on the Revision of the Constitution.

At 3 P. M. Convention adjourned to meet in New York, in August.

LIST OF ATTENDANTS.

BOSTON—J. N Pratt, P. H. Alexander, S. E. Burton, Frank E Clark, C. D. Wainwright, W. A. Boland, Louis W. Burnham, A. F. Mason, H. H Eustis, Frank Ridlon, A. V. Garratt, R. F. Ross.

PHILADELPHIA—David Brooks, A. J. De Camp H. E. Edgerton, G. A Wilbur, Jas. A Pentz, Fred H Tidram, M D. Law, J. E Doughtv, Alfred F. Moore. Prof. A. Breckenzaun.

PLAINFIELD, N. J.—W H. Moore.

COLUMBUS, O.—Chas. F. Scott.

JANESVILLE, WIS.—P. Norcross.

NORFOLK, VA.—Jas. L Belo e.

BINGHAMTON, N. Y.—John Anderson.

SPRINGFIELD MASS.—Alex. P. Wright.

STEUBENVILLE, O.—J. F. Flood.

ST LOUIS—D. R. Russell, G. W. Parker.

WASHINGTON, D. C.—Thos. A Connolly

POMEROY, O.—E S. Trussell.

NEW HAVEN, CONN.—Simeon J. Fox.

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NEW YORK—W. L. Candee, Walter C Kerr; A. H. Patterson, H. L. Lufkin P C. Ackerman, F. A. Magee, Jas P. McQuaide, Edward S. Perot. Jarvis B. Edson, Geo. W. La Rue, E. T. Lynch jr., Robert S. Hubbel, Isaac H. Davis, David H. Smith, Norman McCarty, Brooklyn; E. F Peck. Brooklyn; B B. Nostrand, jr., A. W. Butterworth, Chas A. Schieren. C. H. Barney, F. E. Kinsman, F G Cartwright, Frank G. Stone, Wm. F Cullen, Otto A. Moses, Geo T. Manson, Henry Hine, R. W. Blackwell, G. H. Fisher, W. A. Giles.

ELECTRICALITIES.

It was a great electrical gathering.

There was no lack of good feeling.

The election of officers pleased some and disappointed others—a very natural result of all elections.

The local electrical people of Pittsburgh won high honors for their kindly welcome and generous actions.

S. A. Duncan, as chairman of the executive committee, made himself as numerous as a two legged man could, who was of en called for in half a dozen places at once. He has been an untiring chairman and the convention's success is largely due to his indefatigable efforts.

Pittsburgh is interesting from many points of view, particularly from the electrical.

The special cars from the effete East brought in the liveliest party that attended the convention—and barring say half a dozen of the incontrovertibly ugly ones, it was the handsomest.

Vice-President Byllesby, of the Westinghouse Electric Company, exerted himself in season and out of season to make the visitors' stay a pleasant one.

There were delegates present from all parts of the country, and many new faces were to be seen.

Mr. George F. Porter and Mr. C. O. Baker, Jr, arranged for the special train from New York, and they did their work so well that even all the fellows who were assigned upper berths were contented and happy, in fact preferred upper berths, took them and "liked" them.

There were a number of select dinner parties by officials of the Westinghouse companies, in which entertainments of a most delightful kind were given. That very desirable tact (so often lacking), was displayed which always brought together in these little gatherings congenial spirits from among the large number of Pittsburgh visitors.

There is no more popular or earnest gentleman connected with the association and its work than Mr. Frank Ridlon, of Boston.

Peck, of the Brooklyn Lighting Company, is a quiet looker-on, and yet he is one of the most practical, level-headed men engaged in the local lighting business.

EXHIBITS.

The Phœnix Glass Company, of Pittsburgh, Pa., represented in New York by the genial A. H. Patterson, had a glittering display of glass globes and shades for both arc and incandescent work. Lily and other shapes, with every imaginable tint and combination of colors and hand painting and cut glass.

Full lines of lead armored cables, aerial, underground and submarine, were the display of the Standard Underground Cable Company of Pittsburgh.

The N Y. Insulated Wire Company, represented by J. W. Godfrey, showed a full line of their well known specialties, as did also the Callendar Insulating and Waterproofing Company, and the Okonite Company, the latter company having a particularly fine display, and represented by Messrs. Candee and Manson. Holmes, Booth & Haydens put their "K. K." wire before the public.

Electric motors were plentiful The Baxter Motor Company had a very tasteful headquarters, though exhibiting no motors. They occupied rooms jointly with the Sun Electric Company but the profusion of fresh flowers, beautiful as they were, failed to distract the attention of visitors from the elaborate display of incandescent lamps, ranging from probably "one match power" up to 150 candle power.

The Eddy Electric Manufacturing Company, of Hartford, had in action a beautifully constructed 4 horse power motor of their well known make—100 volts, 1,200 revolutions—the only large-sized motor exhibited at the meeting.

The "C. & C." Motor Company showed one sewing machine motor working a machine, and a rotary fan motor, under the charge of Messrs. Lufkin & LaRue.

Edgerton's motor, in charge of the patentee, was shown in the shape of a combined ½ horse power motor and double-acting reciprocating pump, capable of throwing a half inch stream of water 100 feet, also a couple of overhead fans very ingeniously hung by the motor castings from the ceiling.

The E. P. Gleason Manufacturing Company exhibited a handsome line of plain, fancy and cut glass globes and shades, and a most complete line of fittings, insulating joints, electrolier parts, and in short everything pertaining to the fitting up of brackets and electroliers. Mr. Cullen was in charge.

The Electrical Supply Company, of Chicago, had a complete assortment of their well-known extensive line of supplies.

The Geneva Non Magnetic Watch Company, represented by Mr. Conkling, had an elaborate display of watches fitted with hair springs and balances made under the Paillard patents. Watches surrounded by powerful magnets were ticking away merrily, and in apparent indifference.

The American Waltham Watch Company had a very extensive line of watches containing their non magnetic movements. Mr. H. E. Duncan had charge of this interesting collection, which was much visited.

The Bridgeport Brass Company claimed to have the finest display at the convention, in the person of their handsome representative, Mr. H. D. Stanley, but the claim was disputed by the firm of Baker & Co., of Newark, N J.

The Faraday Carbon Company, of Pittsburgh, was represented in full force by Mr. Geo. Porter—him of the ubiquitous presence and Pullman peripateticity.

The American Link Belt Company had some samples of their ingenious belting on exhibition.

Likewise the Solid Link Chain Company, who make brass chain for various purposes.

Modern Light and Heat, our bright and enterprising Boston contemporary had its vigilant representatives on the spot, in the persons of Dr A. V. Garratt and Prof. R F. Ross, to both of whom we are indebted for interchange of courtesies.

Messrs Davenport, of the T.-H. Company, Stone, of the Ansonia Brass Company and Cram of the Bernstein Company, were close competitors the first day, as to who possessed the most good looks. But when the Western delegates showed up, with Col. Geo. L. Beetle at the head, the young men from the East had to fall back.

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☞ No attention will be paid to communications without the *name and address of the writer.*

We invite correspondence from Electricians, Inventors and the Telegraph and Telephone fraternity and those engaged in Electric Lighting, on matters pertaining to electrical and scientific subjects, and all facts of special interest in connection therewith.

We extend to manufacturers of electrical apparatus an invitation to send to this office any and all facts concerning their business which will be of interest to the public. We make no charge for publishing news.

Subscribers can at any time have the mailing address of their paper changed by sending both old and new address.

Mr. C. C. Haskins, 118 LaSalle Street, Chicago, Ill., will represent the REVIEW in the West

NEW YORK, FEBRUARY 25, 1888.

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The visitors to Pittsburgh were housed at the Monongahela, the Anderson and the Hotal Du Quesne. There was a very lively company at the last-named hotel. Mr. Stockey, of the Brush Company; Mr. Byllesby, of the Westinghouse, were among the parent company gentlemen, with headquarters at the Du Quesne.

Our readers will, we are sure, pardon the slight delay in mailing this edition of the REVIEW. A full report of the proceedings of the Electric Light Convention at Pittsburgh this week is given while the matter is fresh and doubly interesting. Much of this report was obtained by the aid of electricity as applied in the telegraph.

It is gratifying to all the lovers of the spread of electrical knowledge, to note the vigor with which many of our prominent educational institutions have been and are taking up the study of electricity. It has been included in the regular curriculum by many, and will be introduced as a special or elective course by many others. All will fall in line, and ere long we may hope to feel that this important branch of physics will not be glossed over by the process of "cramming" at examinations.

Execution of criminals by electricity is being quite extensively agitated since the publication of Commodore Gerry's comprehensive report on methods of punishment and execution. The new plan has many adherents, and presents many excellent features. While the moral deterrent effect would be undoubtedly more powerful than the present brutal system, followed as it is by *post mortem* ceremonies calculated to almost deify the criminal, the after effect of this proposed instantaneous stilling of all the springs of life while at once taking away all the brutality, would also forbid the now attendant and consequent sanctification of crime. It would simply blot out from existence a life which has no further right to the name.

Electric motors are daily rotating into public favor all over the country. The development of all sizes for all purposes is becoming exceedingly rapid, now that success both in economical working and quality of performance has become, even to the most skeptical, a matter of ready demonstration. And since the always conservative owners of generating plants and central stations have given it the stamp of their fullest approval, the rate of development and introduction has increased at an enormous rate. Already the lighting companies are hoping to ere long be able to rent their entire capacity during the daylight hours, and it is hardly going too far to predict that in many instances in the near future the demand for motor current during the day will exceed the requirements for light during the hours of darkness.

THE PITTSBURGH CONVENTION.

The Convention of the National Electric Light Association, just closed at Pittsburgh, has not been behind its predecessors in point of attendance, interest, or results, and can be fairly said to have been the most successful of all, as it should be.

The attendance was very large, between 250 and 300, and at the very first session it was demonstrated that the members were there for the fulfillment of the original purpose of the association, namely, mutual instruction and improvement of knowledge.

A remarkable interest was maintained from the first paper to the last. But the most remarkable and rather significant development of the proceedings was the intense interest displayed on all occasions involving reference to alternating currents. It cropped up at the very first in Prof. Thomson's paper on "Insulation and Installation," next coming to the surface in Mr. Lange's paper on "Magnetization of Watches," while Messrs. Shellenberger's and Smith's papers were exclusively devoted to the alternating current, as was largely also Prof. Liebig's, though the latter chiefly concerned motors and their efficiency.

Other papers of no less importance in point of instructiveness and general interest were read and discussed. One of the most important papers relating to the welfare of the association directly was very brief, but the line of argument was most conclusive, practical, and utilitarian in result, namely, the immediate increase of the association funds; and we cannot but congratulate the Westinghouse companies for this very generous gift. Let the example be followed, as it should be, by others who have shared in the prosperity springing from these new industrial enterprises, which have made the past decade a brilliant spot on history's page.

The association is constantly growing in numbers and popularity, and every new meeting only adds to the proofs that its members appreciate the advantages to be conferred. Let the good work go on.

PUZZLING MISHAPS.

In one of the mechanical exhibitions, fires were not permitted in the buildings, and a manufacturer of portable engines was obliged to be content with space in a portion where it was impossible to supply his engines with steam from the large boilers.

It seemed as if it would be necessary for him to be content with an exhibit of his engines in a condition which an artist might call "still life." However, having procured a piece of belting, he connected the fly-wheel of the engine with a pulley on the main shaft, and having connected the exhaust pipe of the engine with the boiler of a second engine in the exhibit, he removed the safety valve from the first boiler, so that its inside was in free communication with the outside air.

The operation of the engine served to render it a pump, forcing air from the first boiler into the second one, where an air pressure of some twenty-five pounds was obtained, and used to operate the engine in the same manner as steam.

The authorities of the fair, hearing that a portable engine was being run in violation of the orders, sent a messenger who was a trustworthy negro to examine into the matter. He placed his hand upon the cylinder of the second engine, which was very cold on account of refrigeration of the expanding air, with much surprise, and then opened one of the gauge cocks, upon which the air rushed out, chilling his hand. Returning to the superintendent of the exhibition, he reported that they were running the engine "with a northeast wind, or something or other."

Shortly after that a group of Irishmen came along, enjoying life and joking upon everything there with the merriment which seems to be permitted only to "turfs from the old sod," when this engine attracted their attention. This was a subject upon which they felt a certain degree of familiarity because of their experience with pile-driving engines; although this one lacked the extempore pile ferrule, or a poker hanging to the end of the safety valve lever, to "keep the valve from leaking." One of them tried the gauge cocks, noting the chill, and then looking into the furnace under the boiler, and observing that there was no fire, said to his companions, "Cold steam and no fire is the greatest invention here."

In the same fair there were two dynamos in multiple, when the connecting rod of one engine broke near to the crank; happening at a time when the man in charge of the exhibit was explaining its advantages to a manufacturer. The current from the other dynamo passing at once into this, made it a motor, causing the armature to continue its revolution at a very high rate.

The manager of the electric exhibit called attention to that as proof of the merits of the dynamo, declaring that the continuance of the speed was proof of the small amount of power required to operate the dynamo. The prospective purchaser skeptically remarked that he would like to lubricate the engines and water wheels in his mill with the same kind of oil.

The people watched for the dynamo to cease its motion, but without avail. But as the incident happened to be outside of the experience of any of those present, the cause of the strange behavior was a great wonder.

MILL FIRES IN 1887.

The annual report of the Manufacturers' Mutual Fire Insurance Company contains, among other valuable information, a description of each fire occurring during the year upon property insured by them, whether it was followed by any claim or not, giving as far as possible the cause and time of the fire, the mechanical operation or process in which it occurred, and the method of its extinction.

The fires alluded to are one hundred and sixty-seven in number, originating from twenty-one causes as far as known, and the property upon which these fires occurred comprises the greater part of the textile and paper mills in the northeastern part of the United States. The number and extent of these mills may be understood from the fact that the insurance written by these companies during the past year amounted to $460,591,026.00.

It is well known that these companies have encouraged the introduction of electric illumination as being the safest of artificial lighting for various reasons, but chiefly because it removed the hazard caused by irresponsible operatives going around the mills and lighting gas, producing many fires by their carelessness, in spite of the greatest care on the part of those engaged in the management of the mills.

It is well known that a very large number of these mills have electric illumination, but among the list of fires referred to, there is not a single instance of fires produced by electric lighting apparatus.

However, there is one instance of fire in a box around the main belt in a boiler room, in which the cause is unknown, but it is supposed that an electric spark from the belt ignited some oil which had fallen on the floor.

This immunity from fires due to electric lighting apparatus is not an exceptional instance, as we have understood from one of their representatives that they have not had a fire from such causes for five years and a half, or since the rules pertaining to the proper installation of electric apparatus prepared by their expert, were put in force.

A man of medium size with a gray beard neatly trimmed, and clear eyes that look directly at you as if they were examining the inside of your head, stepped briskly up to the iron railing around the Government telegraph table in the House corridor the other day, and asked if he could send a message. The operator politely told him that general business was handled at the Western Union up-stairs, next to the press gallery. "But this is to the Secretary of War," suggested the would-be customer. "Very well, then, I will send it as soon as I finish this message," said the operator. "If you are busy, I can send it myself," continued the man with the brisk step and the bright eyes, "if it isn't against the rules to let me inside the railing. I am an old telegraph operator myself; I believe I was one of the first that ever took messages by sound." The operator thought he had better work the key himself, but he glanced at the signature of the dispatch to see who his pleasant-spoken customer was. The name was "Andrew Carnegie," and the incident recalls the time when four messenger boys, with nothing in either their appearance or their circumstances to distinguish them from the youngsters who are doing similar work to day, carried the messages for the first telegraph office established in Pittsburgh. They called each other Andy and Bob, and Billy and Harry. Andrew Carnegie is now the best known and richest iron and steel maker in America; Robert Pitcairn is general agent and superintendent of the Western Division of the Pennsylvania Railroad; William C. Moreland is city attorney of Pittsburgh, and Harry Oliver, who has regained his eminence and duplicated his former fortune in the steel business, narrowly missed a seat in the United States Senate.

OUR CHICAGO LETTER.

(From a Special Correspondent of the ELECTRICAL REVIEW.)

Memphis, Tenn., is agonizing over the underground question. The fact is, the complaint is getting to be epidemic, rather than sporadic. The city authorities met representatives of the electric light, the telephone and the telegraph companies at the president's office in the City Hall the other day, and discussed the matter of interference between electric light currents and telephones.

Someone proposed metallic circuits for the telephone people. Nobody seemed to have thought about compelling the electric light wires to go below, and no one seems to have thought that the great trouble could be thoroughly cured by putting both under the soil.

Something not essentially different is working up the good people in Kansas City, and the stories that somebody tells about the failures of the underground systems of Chicago are fully as wide of the mark as statements which used to be current in Chicago in the early days of the underground. These statements go until the various companies, electric light, telegraph, telephone, etc., go perforce below the surface. Then it's all right. Then there are cases, too, where change of heart follows change of occupation. A telephone person might become an electric light fellow, or a telegraph man might become interested in an underground patent, don't you see?

Mr. D. H. Lauderback, vice-president of the Central Union and the Michigan Telepone Companies, has been made general manager of the Edison Company here. This company has, at the present time, within Cook county, some 40,000 lamps in service, has recently placed underground tubes throughout the greater portion of the south division, and a large number of business houses have been wired for the Edison system. The company is erecting a large and commodious central station on Adams street, between Lasalle and Clark after the most approved and latest designs and systems of construction. It is claimed that, when finished, it will be a model of convenience and efficiency.

Prof Barrett made a proposition to the city and county officials, the other day, that the county and city buildings, both of which are lighted by incandescent lights, and are virtually under one roof, should be run in partnership. The question is being considered by city and county authorities.

The Sun Electric Company, of Chicago, has for some months had a proposition, accompanied by a request for a franchise, in the hands of the South Side Street and Alley Committee of the Chicago Council, which is something peculiar.

The committee agreed to report the ordinance, and it went through. The franchise gives the Sun Company the right to cross streets and alleys—underground—in the district lying between Adams and Twenty-second streets, and between the South Branch and the Lake. The company is to pay 2½ per cent. of its gross receipts into the city treasury, and also furnish one street light at each street intersection, at absolute cost, the same to be determined by the city controller.

The committee on fire and water have agreed to the passage of ordinances granting franchises to both the Cushman and Inter-State Telephone Companies. The ordinances are being drawn up by the law department of the city, and will then be put through the mill.

Everybody seems to consider that the transgressors of law should be punished. The average Chicagoan is a law-abiding citizen and likes to see the laws enforced. Parties who feel that way have been complaining that the telephone company was stringing wires overhead in the outlying districts, contrary to law. The sensation was spoiled when Prof. Barrett explained that it was the city which was doing this work, and that the wires were for fire and police purposes. C. C. H.

Chicago, Feb. 24, 1888.

OUR BOSTON LETTER.

(From a special correspondent of the ELECTRICAL REVIEW.)

The Convention of the New England Gas Engineers was held at the Parker House on Wednesday last. Upon invitation of the convention, Mr. Frank Ridlon, the well known electric light manager, was present and addressed the meeting. This was something of an innovation, and Mr. Ridlon has the honor of being one of the first, if not the first, out-and-out electric light man to address a gas convention. It is certainly a step in the right direction. Mr. Ridlon first congratulated all on the coming together of the gas and electric light interests, and spoke of his endeavors during the last few years to bring the matter about. The two have one common interest, that of providing the public with artificial light. It is hardly becoming in us, continued Mr. Ridlon, to designate to our patrons, the public, what that light should be. The present enlightenment of the age has enabled the public to state their preference, perhaps for one kind, perhaps for another, and there is no reason why a combination of gas and electric light interests should not be of mutual advantage to the public and to the producer. I am very glad to meet you here in a friendly manner, as the time has gone by when we met as antagonists. Since bringing about this change of feeling we have been able to recognize a good fellow and fellow-worker in our former opponents, the gas men. In closing, the hope was expressed that all would continue doing their best in promoting this good feeling, and the statement made that occasions such as the one in question would contribute largely toward the closing of the former antagonism.

Some recent tests of the thermostats of the American Fire Alarm Association, in comparison with two varieties of automatic sprinklers of approved types, made in the presence of representatives of the underwriters, gave results in favor of the sensitiveness of the thermostat. In one instance the contact of the thermostat was gummed with glycerine without materially interfering with the operation of the device. One of the thermostats of this make, situated near the machinery in the upper part of a Minneapolis grain elevator, gave an alarm on account of the heat radiated from a hot bearing, before any fire had occurred, or sufficient heat generated to open the automatic sprinkler, which was situated near the thermostat.

The dinner of the Electric Club, at the Thorndike, on Saturday evening, was an unqualified success. The menu was excellent, and put all in excellent condition to enjoy (as all did in a superlative degree) the paper, or rather description without notes, which Mr. A. V. Abbott gave of the Boston steam heating plant. Mr. Abbott's description was given in plain, simple language, and in the straightforward manner which carries lucidity and conviction with it. He gave due credit to the part which electricity plays in the system, calling it one of the main factors in its success. The part referred to is the function of a small electro-magnet working the valves in the converter, so called, wherein the individual supplies are drawn off. After the paper, remarks were made by Mr. C. A. Richards, president of the company, Mr. Thomas D. Lockwood, of the Bell Telephone Co, and others. Among those present were Col. William Ludlow, of the National Heating Co., of New York, Rev. Edward Abbott, Sidney Cushing, F. A. Houston, and nearly all the prominent members of the Electric Club. Vice-President W. J. Denver, general manager of the New England Telephone Company, presided.

The death is announced of Mr. Thomas J. Mayall, of Reading, who, next to Mr. Edison had taken out more patents than any other man. They were not all electrical, however. Mr. Mayall had recently perfected a new system of elevated roads, and a petition for a charter was to have been brought before the Legislature this month.

Boston, February 24, 1888.

Insulation and Installation of Wires and Construction of Plant.

BY PROF. ELIHU THOMSON, OF LYNN, MASS.

READ BY E. W. RICE, JR., BEFORE THE ELECTRIC LIGHT CONVENTION.

I have been requested to present my views on the above subject, and having recklessly allowed myself, in spite of the many other demands upon my time, to accept the chairmanship of your committee on the same subject, I have felt it my duty to at least say enough to provoke a general discussion and interchange of views between others, who may have given more special study to matters in hand. My endeavor, therefore, will not be to arbitrarily lay down any rules; but rather to point out directions in which information may be gained and improvements made.

The subject is certainly very extensive in its scope, and could not be dealt with, except in a very superficial way, in the time at our command, and meanwhile I feel constrained to state that I make no claim to the possession of any of the qualifications which would be requisite for thorough work on the subject.

In the installation of an electric light or power plant, we first of all find that the conditions vary very widely. Its size, location, the distance covered, or length of circuits and the climatic effect met with need to be considered. Then again, the nature of the plant itself, whether arc light, direct incandescent, alternating system with transformers or converters, etc., governs, to a large extent, the conditions of the installation of the wires and of the plant itself. We may, of course, find, in a single station or installation, representations of these and other characters of plant, such as medium potential circuits for power transmission alone.

Three or four years ago, we should have been required only to take into account simple cases of light potential for arc circuits, and low potential direct currents for incandescent multiple arc circuits, but the range now covered may be considered to be from any potential above fifty (50) volts up to several thousands, and any current strength from about one ampere up to several thousands of amperes.

In considering the proper insulation and installing of wires for conveying these potentials and currents, we are required to still further extend our field of view, and divide them into aerial or overhead wires or conductors, and underground systems, and each of these, taken in connection with the conductors for indoor distribution to the lamps, motors, or other energy users. We have thus outlined the field which should be covered in dealing with a subject such as we have before us. "Insulation and installation of wires and construction of plant" would furnish us a subject material to fill a many-paged volume and not by any means exhaust it. May such a work soon be forthcoming.

Concerning the relative merits of overhead conductors and underground conductors, it is pretty generally agreed that except for expense and the difficulties of insulation, and connections from the mains, the underground system would be preferable as avoiding unsightliness, and liability of interference, either by leakage, inductions, or contact with other overhead wires. How to preserve the insulation of lines conveying high potentials, which potentials cannot be avoided if distance is to be covered, without conductors of such size as to have a prohibitive cost, is a vital question. It may well be conceded that when the potentials used are very low, say one hundred or two hundred volts, the difficulties of insulation are very slight as compared with those of the use of two or three thousand volts.

It is a notable fact that, so far as concerns the placing of overhead wires, particularly the wires of telegraph, telephone and such systems, and in some cases of electric light wires, extreme disregard of system or orderly direction for such wires is the cause of much of the unsightly appearance presented by them, and much of the liability to get out of order. The tendency, also, has been to use very light and easily broken wires for telephonic work, such as may at any time come down upon the necessarily strong or electric light wires, strength being synonymous with efficiency in these latter.

It is thought that there is need of some rules or enactments which shall render impossible the mazes of telegraph, telephone, private wires, fire alarm, live wires, dead wires and electric light wires (which for our purposes may be considered as very live wires), such as may be seen in many of our large cities.

Should the wires of all kinds be laid or hung in orderly bundles, having a definite direction and only changing that direction by definite angles, such as right angles, in accordance with a pre-arranged system, I think that much of the objection now existing to the placing of overhead conductors could be eliminated. Add to this a requirement increasing the durability and tenacity demanded for telephone and telegraph wires, and their supports, and the dangers of leaks and grounds would in large measure be removed.

Many trials have been made, and considerable progress has resulted therefrom, in the direction of securing an insulating covering for electric wires, such as may adapt them to the use of high potentials without leakage, and prevent contacts forming by abrasion with other wires. This appears to be one of the most difficult problems in electric engineering. The problem is not so much to find a first-class insulating substance for wire covering, but to find combined therewith, or to combine therewith, the qualities of indefinite durability when exposed to the weather, and great toughness and power of resisting cutting or abrasion. For overhead work, not only is an excellent insulator capable of withstanding very high potentials without leakage or rupture required, but such property must be retained along with the mechanical properties of hardness and toughness for indefinite periods. Besides, the cost must not be too great.

To what extent any specimen or quality of insulated wire, or insulating material for outdoor use, fulfills these requirements is a matter which it is difficult indeed to determine fully, particularly as a test for durability must necessarily require a long time to complete. Indeed, it would seem that our best guide must be the experience gained in the use of different wires on a large scale, under different climatic conditions, and with extremes of heat and cold more or less great.

Aside from the insulation given to a wire by its covering considered purely as an insulator, most stress must be laid upon the requirement of resistance to mechanical friction or abrasion, as tending to give immunity from grounds by contact with other wires, or with tree branches, roofs, cornices, etc.

Toughness and elasticity of the insulation are hence seen to be qualities of high importance. Whether such mechanical tests as will represent the conditions of actual practice in the use of the wire in relation to abrasion and percussion, bending, etc., which may break through the coating of insulator, can be devised and applied to test wire is somewhat doubtful, though without doubt much information may be obtained in the pursuance of such an object.

The retention of the toughness and elasticity for reasonable periods is, of course, demanded, and it is this retention which in otherwise excellent coverings, is often absent, the effect of exposure being to render the materials brittle and porous.

It has often been proposed to make tests of the insulation resistance of the coverings of certain lengths of any wire taken as samples representing an average for such wires, under potential somewhat exceeding that existing under actual use or practice, and so to determine the insulating capabilities of different coverings; but it is my opinion that while such tests are certainly useful and important, and in the case of underground wires or cables, indispensable; yet, for overhead work, since most of the length of the wire is exposed to air only, which is a practically perfect insulator, and since the chances of leakage from the lines, arises most from imperfectly insulating supports, and from accidental contact with other wires or surfaces, additional tests would, in any case, be required to determine suitability of an insulator for overhead lines. In this connection, it may be stated that during thunderstorms, overhead wires are subjected to violent inductional effects, giving rise oftentimes to the momentary charging of the lines with potentials very far in excess of the potentials of any dynamos, and capable of breaking through the wire covering where it may be near, or touch a metal object or wet surface. This breaking through may give rise to a weak spot, which will be followed by the dynamo current itself, if of high potential, and if at the same time other conditions be favorable to a diversion of current. When overhead wires or pole lines are required to pass through and between branches of trees, a condition not infrequent in many of our towns and cities considerable difficulty may be found in preserving the insulation of the line, the covering of which is apt to be rubbed off by the tree branches swaying in the wind. Fastening insulators to the branches for support and attachment of the wires is an uncertain remedy on account of the swaying of the tree taking place in different directions not transverse to the line of wire, so that the wire is strained or detached from its support along with the insulator by the violence of the actions.

Many and ingenious are the devices which the over-zealous lineman makes use of to suddenly, or gradually and mysteriously lop off the offending limb, when the case is exceptionally critical and permission for the amputation of the offending limb cannot be obtained from the conservative citizen whose sidewalk supports the obstacle to linemen's ambition. It is also customary to thicken the insulation of the wire at such places as are threatened by abrasion, by winding on it

a wide band of tough and plastic adhesive tape, such as can now be found in the market. If neatly and thoroughly done, the insulation of the wire may thus often be preserved under decidedly adverse conditions.

It must be admitted that the insulation of a high potential circuit can never be too good, and that, therefore, any measure which may tend to its improvement and preservation is a double advantage, for not only are the dangers of grounds and leaks lessened, but the power of the current to do useful work is assisted

A considerable leakage from a high potential circuit means indeed a loss of power or efficiency of the system; for instance, the loss of one half an ampere of current at a potential of fifteen hundred (1,500) volts would represent about one horse power of current energy lost, costing more than a horse power at the dymano pulley to supply such a leak. This latter consideration is of special importance in dealing with lines feeding transformers with alternative currents at high potentials. With one thousand (1,000) volts in the primary circuit, it is readily seen that a badly constructed or leaky line might easily cause the loss of a considerable per centage of current, such as would reduce the economy of the system more, particularly when running under light loads, at which time it is desirable to secure and to keep up the best possible efficiency.

The wires or cables are to be laid underground their resistance to abrasion is of importance only when they require to be drawn into conduits, or sections of conduits; but when once placed intact they are not necessarily further subject to mechanical injury as they are generally surrounded by protective castings, or tubes.

The total exclusion of moisture and the possession by the wire coverings of a high insulation resistance, are requisites of great importance in such work. The difficulties are with low potentials comparatively easy to provide against but in the case of wires at high electric potentials or pressures, such as are light or alternating current primary lines, such difficulties are much exaggerated.

The least excess of moisture, such as may occur by flaws in the insulation may result in the production of a bad ground, or slight leak due to some original defect, may so improve itself by the passage of a current as to become a bad flaw or a complete connection to earth. It would seem best in all cases not to place reliance upon the integrity and perfection of but a single insulating coating or covering for the wire, but to give to it say three coatings successively applied and which are in a measure independent coverings, all of them impervious to moisture and good insulators. If composed of different materials, the peculiar liabilities to defect of one such coating may possibly be compensated by other qualities in another coating, so that there may be small chance of superposed defect in all coatings alike.

Let but the insulating capacity of each layer or coating be amply good to withstand the potential used and it is difficult to conceive how trouble could arise from leaks due to defective portions of the covering. First cost is, however, a barrier to the perfection of underground systems; to save which cost less effective and cheap structures are often given the place which should be occupied by the more perfect and more costly.

It is important, that in cases in which overhead wires or wires above ground are connected with underground lines, efficient means for carrying inductive discharges to earth be provided, such as is secured by the use of proper lightning arresters; for faults may otherwise be produced in the best underground system of conductors due to static inductional discharges existing during thunder storms at the movements of lightning discharge. These discharges are, in overhead lines, oftentimes quite vigorous and capable of puncturing moderate thicknesses of insulation. They are not to be confounded with actual passages of lightning strokes to the lines which, of course, have an infinitely greater capacity for mischief.

The preservation of the insulation of inside wiring is not difficult where the potentials used are low, nor is it difficult, with due exercise of care and skill in the running of the wires and the selection of suitable courses for them to take, to install simple series of lines, such as those for arc lights, which shall be practically exempt from leakage, unless abraded and brought into contact with conducting objects or moist surfaces involving leak to earth. Unfortunately, owing to lack of skill and judgment and haste in installing, much of the wiring done is not as well done as it should be for the best results.

Distribution of current to groups of incandescent lights upon arc light or other high potential lines should always be undertaken with great care, and it is thought that such work should only be undertaken when exceptionally favorable conditions for avoiding accidental leakages exist; more especially should the potential of the line at the dynamo exceed fifteen hundred (1500) volts, or an amount which would sustain thirty arc lamps in series. One of the important elements of safety in such installations is simplicity and ease of inspection of the wiring, and no concealed wire should be used in them.

Concerning the wires which are suitable for indoor work, and particularly for high potentials, the endeavor has been to combine moisture proof and fire resisting, or rather incombustible materials in the covering. The difficulty has been to find moisture-resisting substances, which would not carry fire, and fire-resisting or incombustible material which would not carry or absorb moisture. The two properties seem in most cases incompatibles. The tendency now is to surround the wire with a first covering of moisture-proof material of the nature of rubber, bitumen, resins, etc., and outside of this to place a second layer, which layer will not carry fire. For house-to house and general incandescent lighting, where the distances from the station are no too great, the direct low potential systems possess most of the advantages, the difficulties of leakage from defective insulation being, of course, at a minimum; but where the distances are so great as to make the required outlay for copper in the conductors practically prohibit the extension of the system, a transformer or converter system, if of good design and economy, may be made to yield excellent results. In such cases, the high potential primary wires need not enter the building, or when they do may be suitably protected, the house or inside lines being of such low potentials as to be run with ordinary precautions as to leakage. However, the integrity of the system would be changed should a connection or leak form between the primary and secondary wires of the transformer, thus connecting the local or house line with the high potential outside mains. Such a connection might easily exist unsuspected and would be a constant source of menace or possible danger, not discoverable by the mere tests for grounds as applied to the primary line at the station The expedient of securely grounding the secondary or local line was devised by me to overcome this difficulty. It insures immunity from the risks arising out of possible leaks from the primary lines to the house lines, because such leaks are at once detected by the ordinary tests for grounds

The consideration of the subject of what appliances are the best for the detection and location of leaks or faults in the insertion of conductors when they exist, and whether the ordinary crude methods are adapted to all cases of such detection, would prolong the present paper much beyond its intended limits, and it will have served its object if it opens up an opportunity or gives occasion for a prediscussion and interchange of experience and ideas upon the general subject forming its title.

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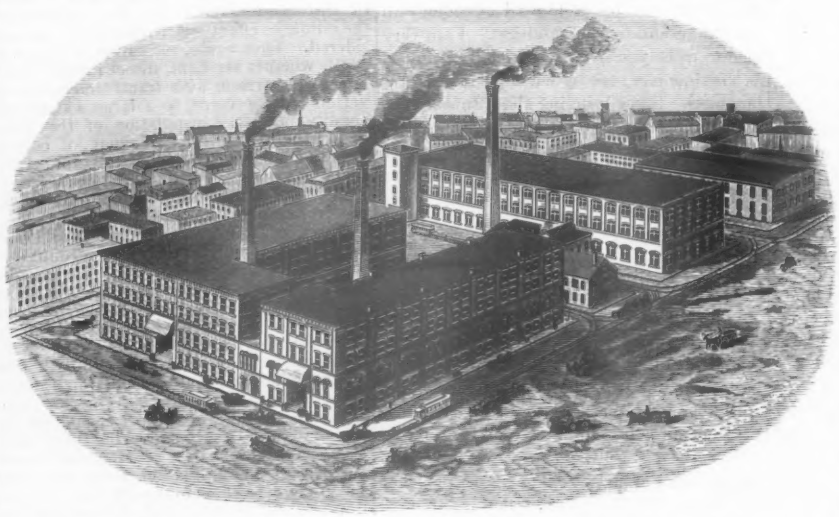
* * In ordinary sunstroke it is reasonable to attribute the sun's share to heat, if for no other reason than that the solar heat is felt. But here there is no sense of heigh ened temperature. Nay, a thermometer placed within five yards of the arc which is melting steel like butter is hardly affected at all. All the heat seems to remain concentrated; and, while at five yards' distance the thermometer hardly moves, bystanders suffer stroke even at fourteen yards. To what else can we appeal, therefore, but to light, pure and simple? The fact is interesting in many ways, but it illustrates once more the active part played by light in a variety of biological phenomena. It may now be asked: Is the skin affected by the red and yellow rays of light, or is it not rather to the chemical rays—the violet and purple rays—we should look? M. de Parville inclines to the latter hypothesis. M. Defontaine is silent; but M. de Parville thinks that by trying the alternate effects on the skin of the red and yellow rays, and the violet rays, respectively isolated, the problem may be capable of easy solution.

The Thomson-Houston Electric Company.

The works of this company are being greatly extended by the addition of their new three story brick factory. The three factories *A*, *B* and *C*, at Lynn, Mass., aggregate more than three acres of floor space. There are now employed about 1,000 men, besides 200 women and girls. One hundred men work all night, in order to keep the testing department up with the shops and product. Eighty tons of castings for dynamo fields, etc., are supplied to the works each week. The lighting of the factories is done by 275 arc lights and 1,200 incandescent. The power of the various steam engines employed, including a large new Greene double engine, just put in by the Providence Steam Engine Company, aggregates over 1,000 horse power, and this will soon be scarcely sufficient. The new engine has two cylinders of 20 inches diameter and 42 inch stroke each. The fly-wheel is 20 feet in diameter, with 38 inch face, and weighs 18½ tons. The belt is leather, 36 inches wide, and connects with a floor countershaft on the second floor of factory *C*. The speed is 100 revolutions per minute and boiler pressure 80 pounds Although each engine is 250 horse power nominally, the engine has developed 500 to 800 horse power in actual running.



View of the Extensive Electric Light Factories of the Thomson-Houston Company, Lynn, Mass.

Boston Personals.

Mr. E. H. Johnson, president of the Edison Electric Light Company, and one of the best informed men in electrical matters in this country, was in Boston this week to attend the hearing by a committee of the city government on the subject of street subways.

A unique contrivance for regulating heat has been invented by F. R. Whitney, of Lewiston, an electrical engineer. It is a combination of electricity and clockwork, and consists of a thermometer carrying an indicator upon it, connected by electricity with clockwork attached to the furnace drafts. The indicator being set at the desired temperature, the moment the temperature rises above that degree it lifts the indicator, which starts an electric current communicating with the clockwork, which immediately closes the drafts. When the thermometer falls a degree the indicator again starts the clockwork and the drafts open. The machine makes a valuable safeguard against fires caused by overheating.

The directors of the Sandwich Glass Company have voted to close their works at Sandwich. The fires have been ordered drawn, and the decorating, cutting, etching, and other departments will be closed. Much anxiety is felt by business men, as this industry is the chief one of Sandwich.

The New York Metal Exchange does not seem "to catch on" to the copper stock business, and is disappointing the Boston members in this matter.

The gas commissioners have granted permission to the New Bedford Gas Light Company to engage in the electric light business, and have prescribed, as the minimum capacity of the plant, 160 arc lights of nominally 2,000 candle power each. T. W. S.

Boston, Mass., Feb. 20, 1888.

ELECTRIC LIGHT NEWS

—— The Sharon (Pa.) Electric Light Company has been organized, and a plant will soon be put in.

—— F. A. Kenny, of Syracuse, N. Y., is arranging for an electric light plant for Thousand Islands, N. Y.

—— The Chestertown, Md., Water Co., C. F. Westcott, president, contemplate erecting an electric light plant.

—— The town of Snowville, Va., is crying out for electric light; so, too, is Maryville, Ohio, and Thorndike, Mass.

—— The Otis Manufacturing Company Ware, Mass., intend introducing the electric light into their extensive works.

—— At New Orleans, the Edison Electric Illuminating Co. will hold a meeting March 5, to decide as to increasing capital stock.

—— The Electric Water Protective Company, 713 Broadway, New York, has issued a catalogue, descriptive of its electrical process for preventing water overflow in all kinds of dwellings.

—— The Edison Light has been adopted by the Dominion Government for the lighting of the Esquimault dry dock, the contract having been awarded to A. J. Lawson, of Montreal. The capacity of Vancouver Edison station is also being doubled.

—— C. A. Murray, of Marshall, Texas, is arranging to put in electric light plants in a number of Texas points. Two companies are under way at present, as follows: Greenville, Texas, a 650 light Westinghouse alternating incandescent plant and at Marshall, Texas, a 650 light Westinghouse alternating incandescent plant.

—— Mr. Bernard, of the Sawyer-Man Company, seems to have rushed business somewhat for this system in Paterson, N. J. Some of the orders for plants put in there by him during the past few months were very large, notably the Wm. Strange Company, 1,600 lamps; Phoenix M'f'g Company, 1,100 lamps; Hamill & Booth, 600 lamps, and Grimshaw Bros., 600 lamps.

—— The Gas Committee of the Brooklyn Council recommends that the following prices be paid for lighting:

Brooklyn Gaslight Company, $19.80 per lamp per annum.
Williamsburg Gaslight Company, $21.75.
Nassau, Metropolitan, People's and Citizens' Gaslight Companies, $22.
Municipal Electric Light Company, $182.50.
Citizens' Electric Light Company, $182 50.

—— The Merchants' Electric Light Company, of Philadelphia, composed of the storekeepers on the west side of Front street, between Susquehanna avenue and Dauphin street, has been organized, with the following officers: President, J. Bossing; vice-president, S. L. Schumo; secretary, H. Barthmair; treasurer, G. Brenninger. A fifty arc light plant will be put in, and be ready for furnishing light in about two months.

—— Articles of incorporation have been filed with the Secretary of State by the Edison Light and Power Company, Troy, N. Y., with a capital of $100,000. Heretofore the company has been conducted as a partnership, but desiring to extend its plant and increase its capital, a corporation was formed. The company now lights the Union depot at Troy. The trustees comprise these well-known Albanians: Chas. D. Hammond, James W. Hutt, Howard L. Browning, George W. Kirchwey, William K. Harcourt, James W. Eaton, jr., and Lynn J. Browning

Independent Engines in Independent Stations.

COMMERCIAL SUCCESS IN INCANDESCENT LIGHTING DEPENDS PRIMARILY ON THE CONTINUOUS, CHEAP, UNIFORM AND FLEXIBLE GENERATION OF POWER

PAPER OF WILLIAM LEE CHURCH BEFORE THE NATIONAL ELECTRIC LIGHT ASSOCIATION. (CUTS OMITTED.)

The service of electric lighting differs from other forms of manufacture in requiring more horse power per square foot of floor space; in requiring higher speeds; in demanding the power in larger units; in compelling a closer and more uniform regulation; and in requiring more rapid and constant extensions. It will be observed that these peculiarities require individual and special treatment in the generation and distribution of power, and engineering practice as determined in other means of manufacture may be sadly at fault when applied to electric lighting.

It has become an axiom among experienced station magagers that the money is made or lost between the shovel and the belt; in other words, other things being equal, the dividend-earning capacity of a station is determined by its steam plant, to which the electric apparatus is in the nature of an accessory.

Incandescent lighting has not until recently made a brilliant record as an investment and much of the disappointment is directly traceable to the culpable ignorance of the principles of steam engineering which has been displayed. A man who will not venture to cut himself a $2.00 vest will not hesitate to exercise his amateur talents upon a steam plant, upon the economical and reliable performance of which depends an investment of one hundred thousand dollars and the public service of a city. A long and critical experience in this branch of industry has grounded us in the conviction that no incandescent station can hope to be financially successful, under the ordinary conditions of competition, unless based on independent dynamos belted direct from independent engines. Throughout this paper, therefore, we desire to keep constantly in view the opposite systems; namely, a station containing a given number of dynamos of two or three different capacities, each belted direct from high-speed engines of corresponding rating, and, on the other hand, the same station with the dynamos driven from one or two slow-speed engines transmitting their power through one hundred feet of shafting, more or less, encumbered with clutch pulleys. Having these pictures well in mind, we inquire:

What are the essential requirements of a first-class steam plant in an incandescent electric light station? Taking them up in the order of their importance, we unhesitatingly say first, and always foremost, *absolute reliability for continuous running.*

The electric light company contracts to supply the demand of a diverse and exacting public, and that public expects to find its light on tap at every moment of every hour of every day in the year. Failure of service in ever so small a degree is palliated by no excuse. Complete reliability is the condition of popularity, confidence and patronage, without which all the other economies and excellencies go for nothing.

Again, electric lighting perhaps more than any other industry has its earnings directly affected by the shutting down of its power, since it sustains a direct financial loss for lights out, aside from custom and reputation, not easily regained. Subdivided power reduces this risk to a minimum, and, properly directed and applied, obviates it altogether. In a a station using, say, 2,000 horse power, say in the shape of two large engines, loss in lamps in one night by the shutting-down of one of these engines is equal to one-half the cost of an independent engine on the subdivided plan; in other words, as tersely expressed by a manager of experience, a company might better, for peace of mind, reputation, and cash balance on the books, throw a sixty horse power engine into the scrap pile than to shut down the station one hour The service of electric lighting is similar to the editing of a daily paper, in that lost time can never be regained. Most industries can make up lost time by working overtime, and pushing their business in various ways, but in electric lighting—

"The mill will never grind with the water that has passed."

Passing from argument to instance, we cite the recent experience of one of the largest stations in the country, operating in the neighborhood of 20,000 lights. This station, as originally planned, was driven from a pair of Corliss engines, each having a cylinder 28″ in diameter by 48″ stroke, and belting to a countershaft 4½″ in diameter by about 50′ in length. From this countershaft are driven five dynamos, having an aggregate capacity of six thousand 16 candle power lamps. Clutch pulleys 8′ in diameter, which are the means of disconnecting the dynamos when not in use with similar clutch pulleys for exciters. The remaining dynamos in the station are each of 2,500 lights capacity, and each driven by a 200 horse power independent engine, belted direct. Recently, in the middle of the heavy run of the evening, one of the clutch pulleys broke in some of its parts, necessitating the immediate shutting down of the 6,000 lights, besides doing considerable damage, and involving danger to the employes. The extinguishing of such a large number of lights at the important hour of the run was a blow at electric lighting of the severest nature, and working serious inconvenience to public gatherings. It happened that one of the independent engines, with its dynamo, was immediately available, and was started within two or three minutes, so as to take up a portion of the load of the large engine. In this same station, at a subsequent time, a key became loose on the valve gear of the engine, necessitating another stop for several minutes. On still a third occasion the crankpin became uncomfortably hot, and was carried through the run only at a great risk and labor. This illustration is used as one among many of the almost evident fact that no electric light station can afford to hang its whole business upon any one source of motive power, particularly when that motive power is distributed through the complex mechanism of countershafting, clutch pulleys, etc., involving a risk of hot bearings, broken pulleys, defective frictions, and what not, any one of which may shut down the whole station. Had these dynamos been each belted from an independent engine, the accidents above enumerated could not have occurred in the nature of the case. We do not assume to say but that accidents of some nature are due in any piece of mechanism; but the division of power and generating capacity into comparatively small units, each independent of all the others, affords a practical means of distributing the danger, so that it is essentially *nil* in its effects; that is to say, had a stoppage of any one independent engine in a similar instance occurred from any cause, the other engines, with their dynamos, would easily have distributed the load for a short time, without any disturbance or danger whatever, and the service would have been uninterrupted while the repairs were being made or the difficulties remedied.

It has been incidentally remarked by a gentleman familiar with the practical operation of a station, that independent engines afford a safeguard against danger from short circuits, inasmuch as currents of the short circuit will overload an independent engine and slow it down, thus giving warning of the danger. If the dynamo is driven from a single large engine, motive power will not respond to the short circuit until the short circuit becomes equal to the full capacity of all the connected dynamos plus the range of power in the engine. Practically, therefore, an engine of this type will not feel the short circuit, but will pull it through until something burns away.

The merit of the steam plant which is most obvious, and which appeals most strongly to the electric light company, is *economy of fuel.*

The advocates of large slow-speed engines rely upon the supposed superior fuel of this type as the sole effect to its obvious disadvantages. All managers unhesitatingly admit the superiority of transmitting the power directly and without loss from the engines to the dynamos, and more or less readily concede that in its performance the high-speed engine will also equal the running qualities and durability of the slow-speed engine. If with this, say they, we could get the steam efficiency of the Corliss engine, no man would hesitate to decide in the favor of the convenient, compact, and independent small engine. We take the question at once by the beard, and desire to state that, of two incandescent stations operating under ordinary circumstances, and otherwise equal, except only in their power and transmission, that one which has independent direct belted engines will show on its monthly report sheet, not a small amount, but from one-third to one-half less coal per lamp hour than a station driven from a single engine through counter-shafting, both types of engines being non condensing We go yet farther, and state that independent non-condensing engines, under many conditions, will about equal in monthly coal account an equivalent slow-speed condensing engine. This is a fact so incontrovertible when actually and candidly investigated, that we do not propose here to demonstrate, but merely to illustrate it.

We now submit the prompt inquiry, "Will not a high-speed engine use more coal per horse power per hour than a Corliss engine?" Yes. "How much more?" Size for size, and load for load, not over 10 to 12 per cent. Score 10 per cent. against the high-speed engine, and again ask, "Will not several small engines use more steam than one equivalent large engine, even of the same type?" Yes. How much more?" Load for load, possibly another 10 per cent. Score 20 per cent against the high-speed engine, and again ask how an admitted loss of one pound of coal in every five can be reconciled with the statement of a monthly saving of 30 to 50 per cent. in favor of independent engines? Answer, simply because we have to deal with conditions as they exist in fact, and not as we assume them to exist.

The reason why independent engines can overcome their moderate lack of initial economy, and pass a large percentage of actual economy to their credit, are mainly two First, the use of a counter-shaft implies power to run it. Indicator diagrams show that the real load of such a plant varies from 12 to 20 per cent. of the gross horse power under full load when in ordinary good condition, and not infrequently rises to 30 per cent. and over, with badly lined shaftings and badly drawing pulleys. Moreover, it must be borne in mind that the dead loss is nearly a constant quantity, and if it amounts to 20 per cent. of the full load, it will under partial load equal, and even exceed, the net power transmitted to the dynamos It may easily happen, and doubtless does happen every night in every station thus far, that from midnight to morning two or three horse powers are expended in the cylinder for each effective horse power recovered at the dynamo pulley.

Thus, by one stroke and by a single item, is the conceded advantage of the larger engine reckoned in coal per horse power, practically swept away, and large and small engines left standing on an equal footing, prepared to submit to the still more searching question, "What is the cost from hour to hour of the power actually expended in meeting the fluctuation of the load?"

To consider for a moment some abstract facts in steam engineering, we must note that the steam engine develops its maximum economy (*i. e.*, minimum consumption,) only over a limited range of its power. Under normal conditions of pressure, say eighty to a hundred pounds in the boiler, this minimum consumption is found only between the points of ¼ and ½ cut-off, say from *A* to *B*, Fig. 1, at which latter point all engines are now treated. At its rated power, therefore, the single large engine of the Corliss type will consume as little as 26 to 28 pounds of water (steam) actually fed to the boilers per indicated horse power per hour; and if the economy were not affected by the load, we could represent the rate of consumption by the straight line *C D*. If overloaded, however, the rate of water consumption rises, as shown on the right-hand portion of the diagram, in which the horizontal distances represent the actual points of water consumption; the curve, therefore, being a curve of efficiency at varying loads, it will now be particularly noted, that, whereas the load rises for an overload, it also rises for an underload, and very much more rapidly. This is well understood to be partly from excessive condensation due to over-expansion, and partly from the greater ranges of leakage under short cut-offs. Considering Fig. 1 to represent the actual performance of a 400 horse power engine at varying points of cut-off, it will be seen that the engine can be at its best only over a limited range, from *A* to *C*, or say from 325 to 450 horse power. An overload is, of course, mechanically injurious which limits the possibilities in that direction. As the load falls off below ¼ cut-off, the steam rate increases at an enormous ratio, so that at 200 horse power, the engine is using 50 per cent. more than its normal rate; *i. e.*, at 200 horse power it is actually using the gross amount of steam which would give 300 horse power if used in a 300 horse power engine. At 100 horse power, waste is fully 100 per cent., and the steam used should develop, not 100 horse power, but 200 horse power if used in a 200 horse power engine. It must be borne in mind that the diagram is plotted from observed facts, and is not a diagram of theoretical deductions.

It now remains to determine if the conditions actually obtained in electric lighting stations are such as will enable a single large engine to develop its normal economy; and, if not, then are they such as will enable the smaller independent engine with a lesser initial economy to reach a better gross result under the inevitable conditions as they are found to exist.

The typical daily chart of amperes delivered from an incandescent station of, say, 4,500 lights, is shown in Fig. 2, of course with variations in different stations, but always of the same general character. The chart is assumed to cover a winter night's run, commencing at 4 P. M., and shutting down at 8 A. M. The heavy, irregular line *A B* represents the fluctuation of the actual load, such as would be determined by indicating a series of independent engines; and the area enclosed between it in the base line *M N* may be denominated by the net power required The fine, irregular line *C D* encloses the gross load when driven by a single large engine, being equivalent to the net load plus the friction of the shafting and pulleys required in transmission. The irregular band lying between *A B* and *C D*, therefore, represents the dead load, which would be a dead loss, due to the friction of the shafting. But, as shown above, this is the full measure of the loss. We have already seen in Fig. 1 that an excessive underload requires a relative amount of steam which would be adequate to produce a much greater power if applied in an engine worked at its point of maximum efficency. Combining the two diagrams, therefore, we would find a third dotted line, *E F*, which would clearly represent the actual steam consumption required to secure the net work *A B*. The irregular band, therefore, between *A B* and *E F*, represents the total loss expressed in coal; in other words, the entire area *E F M N* represents the lamps which should be got for the steam expended, whereas *A B M N* represents the lamps actually got for the steam expended. The loss involved is practically 50 per cent. of the total fuel in the whole night's run, which corresponds to observed results in stations whose fluctuations of load are about as indicated. Of course, there are stations in which the net load averages more uniform than that shown, and a better proportionate result would therefore be expected from the single large engine with countershafting. We believe it is safe to say, however, that there is no incandescent station which will get a load so constant as to secure the economy from a single engine equal to that which can be realized from subdivided power.

We now contrast the performance of independent engines in the same station. The lower narrow band between the lines *M N* and *a a* represents the smallest dynamo, equal to a load of 650 lights. The remaining three bands between *a a*, *b b*, and *c c* represent the other dynamos, or successive loads of 1,300 lights each. At starting time therefore, a 60 horse power engine with its 650-light dynamo is started, and run continuously until shutting down in the morning. It will be noted that, while running, the load on this engine is practically constant and at the point of maximum efficiency. In ten minutes after starting, the load rapidly increasing, it becomes necessary to start the second 125 horse power engine with its 1,300-light dynamo, which engine again runs on its full and most efficient load, as indicated between the lines *a a*, *b b*. This engine is stopped at 12.45, and is therefore running to a disadvantage only for the last hour. At 4 40 the increase of light calls for the third engine with its dynamo, which in turn runs until 10.45, and is then stopped. The fourth engine and dynamo will start at 5 P. M., and run until 9 30. The point to be clearly understood as vital to the whole economic question is, that each engine while running is loaded to its best efficiency runs only so long as its load is called for, then stops altogether, and with it all consumption of steam, leakage, radiation, wear and tear, and loss of every nature. Ample time is given to inspect the engine and dynamo if necessary, and the system as a whole develops the last possibilities of commercial efficiency.

The above diagram practically represents the performance of two stations which we once had the privilege of comparing. Both were practically the same size, and both were constructed on the same electrical basis. We were by courtesy put in possession of the monthly reports from both of these stations, which showed a ratio between the pounds of coal per ampere per hour of 70 to 126 in favor of the station driven by independent engines. A station whose motive power is one or two large engines, therefore, finds itself in a position of earning money between starting time and ten o'clock, and spending it again between ten o'clock and morning.

We have thus endeavored to make it clear in the above illustrations that the rated economy of the two types of engines is but a small part of the consideration, and cuts practically no figure whatever in actual practice under the conditions imposed by the nature of incandescent service.

If any one is now thinking to inquire, why not use a number of small Corliss engines in place of high-speed engines, if it is admitted that the Corliss type is more economical of the two? we would answer briefly, first, small Corliss engines are not as economical as small single-valve engines, the percentage of leakage due to the four valves and slower speed being much greater; second, small engines of the Corliss type run necessarily at so slow a speed as to preclude the possibility of direct belting, and to involve full lines of counter-shafting with their attendant cost and waste of power; third, the first cost of small slow-speed engines is very greatly in excess of that of high-speed engines of the same power. We think no one has ever seriously considered, however, the adoption of small independent slow-speed engines.

Next in importance to reliability and economy is uniformity, delicacy, and continuity of regulation.

There is much misapprehension regarding the matter of regulation in engines used for electric lighting. Let us, therefore, ask, What is good regulation? Good regulation implies, as a matter of course, reasonably small variation of speed, reckoned in R. P. M., between the engine fully loaded and the engine running light. Claims are made that such and such engines regulate to 2 per cent., 1 per cent., and even to one-half of one per cent., under variations of load. Now, it should be clearly understood, once for all, that any decent automatic engine controlled

by the shaft governor can be so adjusted as to not merely to 2 per cent., or 1 per cent., but to actually pass the point of exact regulation, and run faster under load than when light. So far as regulation in terms of R. P. H. is concerned, 1 per cent. or 2 per cent. regulation is sufficiently close for all ordinary purposes.

Second. The most important consideration in the regulation of engines in incandescent stations is not their variation from minute to minute, but from stroke to stroke. An engine may make 300 turns per minute, counted for each successive minute of the hour, and yet may at any given instant be running sensibly above or below this speed, in the effort to meet a momentary fluctuation of load. We say every engine may do this, and we have observed that most engines do this frequently; the difficulty being, not a matter of the construction of the governor, but purely a question of lubrication A perfect governor is one which will maintain the speed, not at an average of 300 R. P. M., but at the rate of 300 R. P. M. for each and every stroke. Any properly constructed governor will retain the average of regulation to which it is set, but it can only secure instantaneous regulation when friction is practically eliminated. It has been our experience that nothing but a complete bathing of the governor in oil will practically accomplish this purpose, and maintain its perfection throughout a long run.

Incandescent lamps require a regulation more delicate, perhaps than any other industry. Any departure in regulation from stroke to stroke gives a variation of electromotive force, which is speedily destructive to the life of the lamp—the item which, next to fuel economy, is the heaviest taxation. The injury is done during the period of acceleration immediately following the change of load, which period is the time between the change of load and the movement of the governor; and this in turn is proportional to the friction. It is obvious that, if friction were annihilated, the acceleration would be also *nil*, and the speed, and consequently the electromotive force, would never vary.

Third. Under the extremely long runs now imposed by electric lighting service, continuity of good regulation is essential; that is to say, a governor which will regulate when well oiled, will fail to regulate when its pins and bearings, being inaccessible under motion, have become dry during a long run.

As to the nicety of regulation obtainable from a slow-speed engine, there is no comparison possible. We have already shown that it is not permissible for an electric light engine to vary its speed, even from stroke to stroke. A slow-speed engine not only may do this, but actually does vary its speed within the limits of a single stroke. All observers know that it is frequently quite possible to count the revolutions of a slow-speed engine, particularly when heavily loaded, by the pulsations in the lamps at a distance from the station. A slow-speed engine, unless excessive in its fly-wheel capacity, will imperceptibly slacken in passing its centers; and this variation, not visible on the engine, becomes a sensible and dangerous variation when multiplied to the speed of the dynamo. The fluctuation of the needle of two voltameters, respectively registering from a high-speed and slow-speed engine will give abundant evidence on this point.

Flexibility.—The characteristic of flexibility in electric light stations is one which is frequently overlooked until experience demonstrates its desirability. To secure the best possibilities in this direction, it is necessary to use dynamos of two or three different sizes—say of 650, 1,300, and 2,500 lights capacity—each being driven direct from an independent. The plant being thus divided into independent units of different sizes in any variation of demand, either in the total load or in the load required for different circuits, can be conveniently met. Owing to local causes, the load of a station is not necessarily the same from day to day. It is obvious that a plant in which all the dynamos are hung upon one, or at most two, engines, is essentially rigid in its control of circumstances, whereas a station planned as above indicated, is to the last degree flexible in meeting any variation of load, to whatever degree it may occur. All this has a direct bearing both on economy of fuel and incidentals of operation.

We would wish to imply that the smallest unit in every station should necessarily be the smallest dynamo—say 650 lights. It is probable that the smallest unit is determined by the minimum load existing at any considerable time during the day. This minimum load in the majority of medium-sized stations will represent about one-eighth to one-sixth the generating capacity of the station; that is to say, a station of four thousand lights capacity should have one dynamo at least as small as 650 lights. Beyond this, it is perhaps advisable that the units be uniform for the sake of interchangeability of parts. The whole question of units of generation must be considered, not in the light of any one rule, but under all the circumstances of each particular case.

Maintenance of Plant.—The maintenance account of a plant often defeats dividends in the use of counter-shafting, bearings, pulleys, clutch pulleys, belts, etc. No practical operator need be told of the repair account and general annoyance from the use of clutch pulleys. There are incidental exceptions, but we refer to the general rule. Each bearing of the counter-shafting will consume oil to the value of at least five dollars per annum, and any considerable amount of shafting involves the pay of an extra oiler to properly care for it. Regarding the two types of engines under discussion, it is undoubtedly true that the maintenance of the high-speed engine will be fully as low as of an equal horse power in slow speeds, as to its actual expense, without taking into account the time lost in repairs. Nearly all high-speed engines are made to gauge with more or less reference to interchangeability of parts. Repairs in consequence are furnished at a minimum of cost; and the parts being light and readily handled, the engine can be stripped and overhauled and connected up without the employment of an extra force of men or the necessity of heavy handling. In referring to high-speed engines, we of course only speak of those which are carefully and understandingly designed for the work put upon them; that is, we wish to draw a sharp distinction between high speed engines and engines speeded high.

Space Occupied.—This is one of the minor considerations which in certain locations becomes of considerable importance. Not infrequently electric light stations are located near the business portion of a city, where real estate is valuable, and taxes correspondingly high, and space counts heavily in the capitalized investment.

Again: a large building obviously increases the investment, particularly when we know that a building to carry heavy lines of shafting at high speeds must be of unusually massive construction. It needs no illustration to show that independent engines, by doing away with the space occupied by counter-shafting and belts under the least distance between centers which can be justified, require materially less space per horse power than any form of non-subdivided power. This is particularly the case where the dynamos are placed on the second floor, over the engine room.

Moreover, the cramped space in which the single engine must develop and distribute its power is against its satisfactory performance. The fact is generally overlooked, in drawing comparisons, that a single large engine in an ordinary manufacturing establishment, such as a cotton mill, has in the nature of the case a wide space in which to transmit its power from the slow motions of the engine up to the high speed of the spindles. This means that ample space is given to bring the speed, by gradual accelerations, through easy moving shafting of substantial nature, up to a moderately high intermediate speed, and then distribute it to the spindles in small quantities, by means of simple and light fast-running devices. In the dynamo room, on the contrary, the space is cramped to the last degree, and the slow-running engine must, in short range, multiply its power to high velocities, and transmit its speed in large units to the dynamos. The whole system of transmission becomes rigid and ineffective, and the loss consequent upon friction, and risk to employes, and the magnitude of disaster when any occurs, are such as in themselves to overbalance all the economy which the most enthusiastic advocates of slow-speed engines attribute to them.

Extension of Plant.—An electric light station, unlike most other industries, is usually of very rapid and persistent growth, to an extent which is not generally foreseen in the original calculations. The use of independent engines lends itself readily to indefinite extension. The power and dynamos both being divided into like units, each independent of all the others, extension becomes merely a question of more units, without any special prepation in the plan.

First Cost of Plant.—This consideration, although really of the least importance among those enumerated, is distinctly on the side of subdivided power. The price of the high-speed engine per horse power is now fully as low, and generally lower than, that of slow-speed engines. Cost of foundation is materially less, as is also cost of erection and handling for repairs. There then comes into the question the clear saving of all the money invested in countershafting, pulley blocks, heavy belting, clutch pulleys, pulleys, and similar devices. In the station to which we referred above, the extra transmitting devices necessitated the investment of a sum not less than $6,500. The price thus expended would be sufficient to purchase practically 500 horse power of independent engines, adequate to generate 6,000 lamps, showing practically net earning capacity of at least $18,000 per annum. When we contrast this with the net losses due to the systems of concentrated power, as above discussed, it leaves no room for argument as to the advantages of independent engines in electric light work.

ELECTRIC MOTORS.

PAPER READ BY G. A. LIEBIG, JR., BEFORE THE NATIONAL ELECTRIC LIGHT ASSOCIATION, PITTSBURGH, FEB. 21-23.

The development of the electric motor from its primitive form up to its present state of advancement and usefulness has been similar to the growth of nearly all of those great discoveries which have proved themselves at first so adaptable and then so necessary to the wants of everyday life

The history of the motor is a very remarkable one, not only as a story of rapid improvment, but also because its first chapters belong to very recent times

We can now ask ourselves, not without astonishment, why it happened, seeing that the laws of the conservation of energy were so generally accepted, that the reversibility of the dynamo and motor was so lately discovered. It is quite true that the first motor was built many years ago, but for a long time, even after the dynamo had undergone many marked improvements, the motor was not turned to practical account. In other words, dynamos and motors have all along been kept distinctly apart, and even to-day there exists sometimes a certain indefiniteness about their relation.

We now know that the general term "Dynamo Electric Machine" includes not only generators of electricity, but also appliances for converting electricity into other forms of energy, and that all the mathematical formulæ which have been applied to the dynamo as a generator of electricity are equally applicable to the dynamo when viewed as a source of motive power. The only changes necessary in any formulæ relate to the algebraic signs of certain symbols.

The feature of reversibility is of extreme importance, and means that any rule of construction or of design that tends to make a dynamo machine an efficient apparatus will give identical results when used in connection with motors. Other considerations may present themselves, questions of speed and output per unit weight of material may arise, and these may be different in the two cases, but they are of a mechanical, or at any rate, secondary interest, and in no way affect the mathematical considerations. In what follows, therefore, we shall use the term "dynamo electric machine" to designate, unless otherwise specified, either a generator of electricity or a dynamo reversed, *i. e.*, a motor.

In order to give an intelligible review of the work which has been done on dynamos and prepare the way for a few considerations which will follow, it may be well to describe briefly the component parts of a dynamo electric machine, and refer to the purposes for which they are intended. In every dynamo we must have a continuation of the following elements:

(*a.*) An iron body or framework constituting the magnetic limbs. This is always wrapped over a certain portion of its length with insulated copper wire, and its purpose is to produce between its ends, or polar surfaces, a region of magnetic force.

(*b.*) A series of coils of copper wire, generally wound upon a subdivided mass of iron, and capable of revolution about an axis in such a way as to make each coil pass successively before the polar surfaces of the magnetic limbs. This is called the armature, and is always so placed that it helps with the magnets to form a nearly closed magnetic circuit of iron.

(*c.*) A commutator, which is merely the projected ends of the armature coils, and which, revolving with the armature, effects a continuance in the direction of the currents formed alternately plus and minus.

(*d.*) Several brushes or collectors, usually two in number, consisting of pieces of metal which press upon the segments of the commutator, and which are in metallic communication with the terminals of the machine.

In general, the armatures revolve between the poles of the electro-magnets, but in some machines, notably those intended to furnish alternate currents, the armature is stationary and the magnet coils themselves revolve. This is, however, immaterial, inasmuch as what we have to consider is the relative motion of the parts of the machine, not their absolute movements.

It appears, therefore, that the dynamo machine, since it consists, broadly speaking, of an electro-magnet and a revolving coil of wire, is a very simple piece of machinery, yet it has taken years of hard labor and patient investigation to evolve from the spinning disk of Faraday the dynamo of to-day. There is a feature in the history of the dynamo which must appear remarkable to everyone thinking of the subject. When we remember how much attention has been directed to dynamo machines, not only by practical, but also by scientific men, and recollect that all the materials for a complete theory of the dynamo have been for several years at hand, we are inclined to wonder at the absence of such a theory. Even to-day no complete theory exists, though we are in an immeasurably better position in this respect than we were five years ago. For what we now know, in so far as it is immediately applicable to dynamos, we are mainly indebted to the labors of Clausius, Hopkinson and a few others. It is sometimes claimed that the theory of the dynamo has been seriously crippled by the want of sufficient knowledge regarding the law of electro-magnets, namely, the law connecting magnetic force with the magnetism thereby produced in magnetic bodies. If we admit that an empirical formula is required, we must admit the justice of the claim, because no accurate expression of this kind has ever been originated. But we shall see that it is by no means necessary to depend upon empirical laws; all that we require are the causes of magnetization, and these have been before the world for some years. However, we now possess the results of a new series of investigations on magnetization and magnetism and magnetic permeability, undertaken at home and abroad, among which the most important are those of Hopkinson, Ewing, Rowland, Waibing, etc. These results, in connection with the work already referred to, make it possible to calculate to a close approximation—at least for certaim forms of machines—just what any given dynamo will do when we know, besides its dimensions and configurations, the kind of iron used in its manufacture.

The word magnetic permeability, used above and which enters so frequently into dynamo calculations, is defined by Maxwell (Vol. 2, p. 50) as the ratio of magnetic induction to magnetic force It is also called magnetic inductive capacity, corresponding with specific inductive capacity in electrostatics. Following out an analogy in a different direction, it sometimes happens that magnetic permeability is called magnetic conductivity, or resistance, the idea being to express the varying resistance offered by a given body to the production within it of "lines of induction," just as the lines of flow are opposed by a porous solid, through which is forced an incompressible liquid. Further, we know (Maxwell, Vol. 2, p. 51) that the magnetic induction is related to the magnetic force in exactly the same way that current is related to electromotive force, namely, we have:

$$B = u\,H \text{ and } C = R\,E,$$

when u is the permeability, and R the conductivity. But the analogy is in a sense imperfect, for whereas R (conductivity) is a constant, in so far, at least, as it is absolutely independent of the current flowing (leaving all heating effects out of consideration), the permeability is by no means a constant, but depends not only upon the present state of the material in reference to the induction within it, but also upon its previous "magnetic history." Thus it is a variable quantity, and, for magnetic bodies, grows less and less as the magnetizing force increases. We can, therefore regard the analogy between B and H on the one hand, and C and E on the other, as holding good only when H is a very small quantity.

In the calculations applied to dynamos it is extremely important to know the distribution of magnetism and the polar surfaces of the electro-magnets; that is, the number and direction of the lines of induction from pole to pole. A solution of this problem can be arrived at mathematically in an approximate way only, and then, as a rule, by the consideration of what takes place in the least complex forms of surfaces. To attain certain ends, the graphic method may be applied, either rouguly, by the use of iron filings, or more carefully by the employment of a small magnet suspended by a film. By observing the positions assumed by this small magnet, when fully suspended in different regions of the magnetic field, we can form some idea of the form of the field. For we know that the direction given by the magnet coincides with the resultant direction of the magnetic force at that point (the needle being supposed so small as to exert no disturbing influence), and also that the relative number of lines of force in a small space surrounding the point measures the relative field intensity. The positive directions of the lines of force may be taken as from the north pole to the south pole, both outside and inside the magnet; and they are related to lines of induction in this way: Outside the magnet they coincide; inside the magnet, they are in opposite directions. This amounts to saying that the lines of induction are continuous, whereas the lines of force are not.

Other methods of measuring the field intensity of dynamos have been proposed, such as the magnetometric method. The results so obtained are, however, inaccurate; and, indeed, the method cannot be applied at all when the armature is in place. Nor can the very simple pendulum method devised by Sir Wm. Thomson be applied, because the air space between the armature and magnets is too small. It can, of course, be used by removing the armature, and it has the advantage of giving results directly in absolute measure. Unfortunately, measurements obtained under these circumstances do not give us a reliable basis for calculations, inasmuch as the form of the magnetic field is strongly influenced by the presence or absence of the armature, at least when it con-

tains iron. It may be remarked that magnetic distribution is exactly analogous to electric distribution, especially in the case of dielectrics, and that the geometric form which influences the latter plays almost as important a part in the case of magnetic distribution.

We are well aware that the density of electricity in a given portion of a charged body depends upon the shape of the body, and also upon the presence near it of other charged bodies. The same laws of surface densities determining the so-called leakage of lines of force obtain in the case of magnetism. In almost all dynamos the pole pieces have necessarily somewhat sharp edges, and the number of lines of force per unit area is greater at the edges than on the remaining polar surface. This number is subject to a change when the armature is in place, and to a further modification when the armature revolves, on account of the changes in the direction of the axis of magnetization of the latter.

These considerations show us that any system of measurement which will give useful results must be of such a nature as to be applicable to the dynamo when in working order. The ballistic method fulfills these requirements, it is sufficiently accurate, and, moreover, involves no special difficulty. We have simply to surround that part of the magnetic circuit of which we want the induction, with one or more turns of copper wire connected with the ballistic galvanometer, and observe the throw of the galvanometer needle when the magnetism is reversed or reduced to zero. It is always better to observe the deflection of the galvanometer needle due to a reversal of magnetism. An uncertainty always attends a reduction to zero, owing to the phenomenon of residual magnetism. The galvanometer having once been calibrated in absolute measure, we can, from the throw of the needle, calculate the value of the total induction within the wire, and the magnetic force is known from the data of magnetizing current and number of revolutions. The experiment is repeated for the different parts of the machine, so that we finally obtain the values of the induction throughout the entire magnetic circuit. Suppose, now, we have measured the field intensity, and have a value of the induction per unit area, we can then, by Faraday's law, calculate the electromotive force which would be set up in a conductor moving in any manner in the field. The law is this: The E M.F. produced in a conductor moving in a magnetic field is equal to the rate of cutting the lines of force. If the conductor forms a closed circuit the E.M.F. depends upon the area of the circuit. Hence, in order to be able to determine the E.M.F produced in an armature, we must know the mean area of the coils of the armature, the strength of the magnetic field, and the velocity of rotation.

Call N the total number of lines of induction (flow of force) passing through the armature, and p the current; then we have for the force X acting when the circuit is displaced through the distance $d\,x$, by the principle of the conservation of energy (Maxwell, vol. 2, p. 137):

$$X = -p\,\frac{d\,N}{d\,x}$$

Hence the movement is aided or resisted according as the number of lines of induction passing through the armature is increased or diminished by the movement. The work done during the displacement is

$$X\ d\,x = p\,d\,N$$

and if the number of lines of induction is changed from N to N' we have for the whole work

$$S\ X\ d\,x = p\,(N' - N)$$

Let us divide both sides of the equation by $d\,t$ and we have

$$X\,\frac{d\,x}{d\,t} = p\,\frac{d\,N}{d\,t}$$

as the rate at which work is done. But $d\,N/d\,t$ is the rate at which the lines of force are cut by the moving conductor, and is equal to the E.M.F. produced in that conductor. We have, therefore, for the rate of doing work, the activity

$$p\,e = \frac{E - e}{R}\ .\ e$$

the well-known expression for the activity of the motor. We shall now briefly refer to the investigations of Clausius* and Hopkinson,† as their work, though differing in character, is of extreme importance. The theories published by these two scientists are distinct and characteristic of the two ways of regarding magnetic phenomena: Hopkinson's method is based upon the fundamental laws of electro-magnetism one law expressing the relation between current and magnetic force; the other a condition which always holds for magnetic induction. They are as follows: The line integral of magnetic force around any closed curve is equal to zero, unless the curve surrounds a current, in which case it becomes four times the total current through the curve; the other is the equation of continuity applied to magnetic induction, which means that a line or tube of induction cannot end at a point in space. According to the last law, therefore, if we find that the magnetic induction has different values in the different parts of the magnetic circuit compassing the dynamo, we know that there has occurred a leakage through the air. For instance, the total induction through the armature in every dynamo is less than the total induction through the magnet limbs; the excess, therefore, has passed beyond the limits of the iron body into the air from pole to pole.

The two laws just given furnish a means of constructing the characteristic curve with considerable accuracy *a priori;* that is, the curve showing the relation between electromotive force and current for the total induction, nearly proportional to the induction through the armature at a given speed, determines the electromotive force generated. The data required for calculating the line integral of magnetic force are: the general configuration of the dynamo, specification of the kind of iron used, and the sectional areas and length of the different parts of the machine, the magnet limbs, armature yoke, pole pieces, and from these the "magnetic lengths" can, in general, be estimated. The variables chosen are the total induction through the armature and the current around the magnets; certain sufficients occur in the equation expressing the relation between the induction in the armature and that in other parts of the dynamo. They are approximately constant, and can be estimated when their values for a machine of given form are once known. In a machine on which experiments were conducted by Drs. T. and E. Hopkinson, the difference between the induction through the armature and magnets amounted to about thirty per cent. As an indication of the power of the method and the accuracy with which the results obtained from one machine can be applied to dynamos of very different form, it may be recalled that the characteristic curve of the "Manchester dynamo" was constructed before the machine was built, and was found to require no correction afterwards. In this case the dynamo possessed not only an entirely new form, but was also compound wound.

The theory of Clausius is founded upon consideration of a totally different character, as is undoubtedly less readily adaptable to practical manipulation. The theory is based upon Ampere's well-known laws of the action of currents on conductors—an action which is supposed to take place at a distance and not through an intervening medium, as explained by Faraday, Maxwell Thomson, and others. Clausius expresses in his fundamental equations the material potential of the currents of the dynamos upon one another, and to determine the magnetic movements of the magnets and armature, he adopts, however, with considerable unwillingness, Frölich's formula of induced magnetism. This formula has been extensively used and generally under the form:

$$M = \frac{a\,i}{1 + b\,i}$$

in which a and b are constants and i the current. There has always existed a more or less marked opposition to Frölich's formula as not giving results in accordance with experiment, though the curve it represents is a practically straight line near the origin. Investigation has shown, however, and Hopkinson has called attention to the fact, that the curve should have a point of inflection at the origin, and hence it must be slightly concaved downwards (*i. e.*, towards the axis of abscissæ) during the first part of its course. Clausius has remarked that it would be better for a dynamo if the core of the armature remained stationary, whilst the coils alone revolved. Mechanical appliances, of course, preclude the possibility of such an arrangement, yet we shall see that the other considerations support the view of Clausius. In the case of two machines, one used as a dynamo and one as a motor, the author has shown that its velocities of rotation necessary to secure maximum work are not in the ratio of one to two, as generally believed, but approach this value as the speed of the generator is increased. This, however, only refers to the condition existing when the work done by the generator is not limited. When the work is determined he shows that there can be no relation between the speeds of the machines in order to give a maximum of work done by the motor.

Another theory, though scarcely a distinctive theory, has been advanced by Dr. Frölich, and much work of the theoretical character, besides that mentioned in reference to dynamo-electric machines, has been done, but the most important have been referred to.

There is one point which may as well be mentioned at this place about dynamo construction, which seems to have been the origin of exceedingly contradictory opinions. It is in reference to the position which the coils of the wire should occupy on the field magnets. In some cases we find the coils heaped up toward the middle of the magnets, in some cases toward the pole-pieces, whilst in by far the majority of machines the coils are evenly distributed the whole length. Theoretically, the latter system of winding should be just as effective as the others, and being less complicated, should be used on that account. Prof. S. P. Thompson recommends in his book that the layers should be most numerous around the middle of the magnet limbs, in support of which view he calls attention to the form and number of lines of force from a straight bar magnet in which there is no leakage all along the bar from pole to pole. The conclusion is, however, unwarranted, and the comparison valueless, because in dynamo machines we are dealing with as nearly as may be closed magnetic circuits, and because the distribution of magnetism under such circumstances is entirely different from the distribution in bar magnets, whether long or short. The remedy for leakages which do occur is not to be found in the peculiar shape of magnet coils, but in the quality of iron and lengths or sectional areas of the magnetic circuit.

The question of the regulation of motors now demands our attention, and we shall have to consider the methods adapted to meet the requirements of the two systems of electric distribution now in vogue. We can say two systems, because up to the present motors have not been successfully used on alternating current circuits, whatever may happen in the near future. The two systems known as the constant current, or arc light, and constant potential, or incandescent lamp system, necessitate in motors methods of regulation which are entirely different. For constant potential work we can use either a "shunt" or a "compound wound" machine. In the latter the main or shunt coils are in shunt with the armature and series coils or with the armature alone, the series coils being wound in a direction opposite to that of the main magnetizing coils. This system seems to have been first proposed by Messrs. Ayrton and Perry, and is described at some length in Thomson's book on "Dynamo Electric Machinery." Busanquet (Phil. Mag., vol. XV, p. 275,) arrived at a law of winding similar to Ayrton and Perry's, but deduced from entirely different considerations. The elementary treatment of machines of this type is too well known to require special attention; it is sufficient to say that machines so constructed regulate very perfectly—*i. e.*, run at a practically constant speed, and have been extensively used. It is, however, by no means necessary to employ a differential winding of field magnets, as has been mentioned, in order to secure regulation in motors. The same results are obtained by the use of a simple shunt arrangement, provided there exists a certain relation between the resistance of shunt coils and the armature. Indeed, many constant potential dynamos, with excellent regulation, have already been made in this manner, and motors on the same principle are rapidly coming forward.

It has been stated that compound wound motors, *i. e.*, shunt motors with series regulating coils, will not run at an invariable speed when the load changes, if supplied with constant current, unless the speed is such as to reduce the efficiency to 50 per cent. or less. The statement seems inaccurate; an efficiency of fifty per cent. having nothing to do with its regulation.

Of the losses which occur in motors we have in all cases to take account of those which are due to the following causes:

I. Heating of wires equal to

$$C^2\,R \text{ or } E^2/R.$$

II. Foucault currents in pole-pieces. This depends upon number of armature section, *i. e.*, fluctuations of current, and is generally small unless the Pacinotti form of armature is used.

III. Foucault currents in armature. This depends upon (strength of field)^2 and in the modern laminated armature may be neglected.

IV. Reversals of magnetism of armature equal to $\frac{1}{4}\pm$ Casicine force $\times$ maximum induction $\times\ n\ \times$ volume.

That is, it depends upon (strength of field)^2 and velocity of rotation. No amount of subdivision of armature coil can affect this except in so far as it modifies the total volume of iron in the armature. However, a low magnetic resistance is necessary, and to secure this the armature must contain much iron. It is on this account that an advantage from a stationary armature coil would be derived.

V. Momentary short-circuiting of armature coils, depending upon caef of ceef and mutual induction of armature coils and strength of field.

VI. Finally: Friction in bearings This is difficult to estimate. If the belt is such that Main's principle holds true, losses due to friction are constant.

In regulating motors the speed is constant, or nearly so, hence the causes of the dissipation of energy are confined to variable currents in the conductors and to changing field strength. These in compound wound and constant current motors depend upon the load, but as we see at once are practically constant for a properly made shunt machine. For a pure shunt machine, therefore, the efficiency, provided the speed does not change, is independent of the load.

Before bringing to a close the few remarks which I have ventured to make on the subject of electric motors, it may be interesting to give a few facts regarding the growth of the motor industry, and point out how various are the demands made upon the machines for manufacturing and commercial purposes.

Through the kindness of the Executive Committee of the National Electric Light Association, I am enabled to bring before you a few figures, which will, I trust, act as an incentive to increased activity in this direction.

The committee has addressed circulars to 234 companies engaged in electric lighting, with the following questions:

I. Number of motors in operation.
II. Size of motor.
III. Maker's name.
IV. Current used.
V. Charge per H. P. per month.
VI. Charge per month per arc and incandescent lamp.
VII. Results as to service.
VIII. Consumers' opinions as to power and service.

As a result, answers have been received from fifty-six companies, and from these replies the following statements have been gathered:

Average charge per H. P. per month, 10 hours' run	$10.00
Average charge incandescent lamp, 10 hours' run	13.50
Average charge per arc lamp till 10 o'clock	9 83
Average charge per arc lamp until 12 P. M.	13.00
Average charge per arc lamp all night	22.00
Highest charge per H. P. per month	15.00
Lowest charge per H. P. per month.	6 25
Highest charge per incandescent lamp per H. P.	21.00
Lowest charge per incandescent lamp per H. P.	11.25

The motors supplied with current have been used for the following purposes: Driving ventilator fans, collar and cuff machines, printing presses, various apparatus in repair shops, sewing machines, coffee mills, machines in gun shops, sausage machines, elevators, lathes, pumps, saws, ice-cream freezers, organ bellows, appliances in laundries, etc., etc.

Sizes of motors have varied from ⅛ to 15 H. P. Twenty-six companies have supplied motors from arc light circuits, 14 from arc and incandescent, and 16 from incandescent lamp circuits alone. In 34 cases subscribers own motors and pay per month for current; in other cases companies own motors and charge rental for same. Companies are endeavoring to have subscriber own motor in all cases and pay for current. Electric light companies are satisfied and willing to enlarge the business. Consumers reports are also very satisfactory.

Although the number of cases cited above is small, it is still enough to show us how effectually the motor can supplant the steam engine, especially for those purposes for which the power required is small and under complete control. The opinion of those who have used electric motors indicated that they do their work well, and encourages us to expect a brilliant future for this branch of applied electricity.

* Clausius. *Phil. Mag.*, 1883.
† J. Hopkinson. Proc. Roy. Soc., 1883.

Invoking the Aid of the American Surety Company, of New York.

The American Surety Company, by its vigorous prosecution of defaulters throughout the United States and the Dominion of Canada, has obtained a wide reputation for promptness and efficiency in that direction. The company receives many inquiries from sheriffs, detectives and others touching upon the capture of runaways, but the following communication from a sheriff in far-off Washington Territory, shows that the company's exertions are felt everywhere:

OFFICE OF THE SHERIFF OF WHITMAN CO.
L. P. BERRY, Sheriff.
COLFAX, WASH. TER., Jan. 25, 1888.

"*American Surety Co., of New York:*

"I had a man get away from me last fall and I would like to get him if it is not going to cost me too much. He got away from me by my own carelessness, and the expense of getting him will come out of my pocket. I think he is in New York, Philadelphia, or Albany, N. Y. I can furnish a good photo., and description, and other information. Please let me hear from you. Yours truly,

L. P. BERRY, Sheriff."

It is needless to say that the company was obliged to advise the sheriff that it had all it could do, even with its large corps of operators, to capture and punish those whom it had bonded, without going into the business of a general detective agency.

Telephonic News

*** The Boston *News Bureau* says: "From present plans the Bell Telephone will spend about $3,000,000 the present year in long distance telephone, and will probably extend the system to Chicago. The present lines between Boston and Philadelphia cost $1,000,000."

*** C. D. Crandall, secretary and treasurer of the Missouri and Kansas Telephone Company, will be a New York visitor next week. Mr. Crandall has decided to remain with his first love—the telephone company—although he had about decided to accept a flattering Chicago offer.

*** Captain Gifford, of the Ohio Valley Telephone Company, says, in reference to the bill introduced before the Kentucky Legislature by Senator McCann, and proposing to reduce the rental of telephones to $3 each, that in the event of its passage it will be impossible for his or any other company to do business there and make expenses.

*** The party of Western Union Telegraph officials who arrived in Denver a few days ago have perfected arrangements for increasing the telegraphic facilities between Colorado and the East. New wires are being put up in Colorado, and two new wires have been strung along the Missouri Pacific from St. Louis and Kansas City to Pueblo, one of them being copper wire.

*** The Attorney-General of Pennsylvania contends that the American Bell Telephone Company, of Boston, should pay taxes in that State, as it has an interest in the telephone used there. The Pennsylvania telephone companies, it is shown, paid taxes to the amount of $40,000 for the years 1884, 1885, and 1886. The court at Harrisburg, before which the case was tried, reserved its decision.

*** Another telephone bill is to be introduced by Senator Adams in the Ohio Legislature. It will fix the rate for an instrument at $3 per month and $2.50 when more than one is used by the same firm. Fifteen cents is to be the charge for the first five minutes and five cents for each subsequent five minutes for the use of lines connecting different towns. A penalty of $100 to $500 is attached, and the agent or officer collecting in excess of es'ablished rates is to stand committed until the fine is paid.

*** A Chicago exchange says: There are a good many telephone schemes in this city awaiting an adverse decision on the Bell patent or any other event that may be favorable to an opposition company. The Cushman telephone has a considerable number of friends, and there is quite a large interest in the Globe Company. It will be remembered that the Globe Company controls the Meucci patent. It will unite with the Drawbaugh and other opposition interests in the event of any happening unfavorable to the Bell Company."

*** A new treaty between the Bell Telephone Company and the Rochester People's Association is said by a member who read it to be as follows: "The only important objection that Colonel Parker made to accepting the committee's offer was in regard to a local director. The company objects to any one being a director who is not a stockholder, and as none of the stock of the company is owned here no one is qualified to take a directorship. The company intend to increase the capital stock, and propose to put $50,000 worth of the increase in this city, if it will be taken. The stockholders will then want to elect their own choice to the board of directors. No one was ever known to be elected director of a company who had no stock in it."

*** An auxiliary fire alarm system is to be introduced into the mills in Fall River, by which an alarm can be rung from any room in the mill.

*** The Edison Electric Light Co., of Philadelphia, Pa., are about to increase their plant in that city by the addition of 3,450 horse power boilers, and after a most rigid investigation, have decided to use the Abendroth & Root safety boiler. The Abendroth & Root Manufacturing Co., 28 Cliff street, N. Y., are now at work upon the first portion, 850 horse power, the others to follow as soon as buildings can be prepared.

*** The Lawrence, Kansas, telephone exchange has 163 subscribers, all of whom are well pleased with the service since manager A. D. Hawk took hold of the exchange. The Lawrence *Journal* says: "Mr. Hawk has been in the city only a few months, yet in that short time he has put up many new lines, repaired old ones, and greatly improved the service. He is the best manager Lawrence ever had, having been in the employ of the company many years. He has three excellent operators, who are always attentive and quick to respond to the calls with the usual 'What number?'"

*** Cheap telegraphy is claimed by the inventor of a silicanized copper wire, which, having less electrical resistance than other wire used for telegraphy, will do the same service at less cost, in connection with an automatic machine. The machine, some form of which is already in use, takes a ribbon which has been punctured and cut with dots and lines (like the Morse alphabet), and, being started up, communicates over the wires the symbols for letters as fast as a man can turn a crank. A special and valuable novelty in the system and machine is the facility which they give to anybody who has much telegraphic correspondence to use a cipher. With the perforating machine on his desk, the correspondent can puncture the paper ribbon according to his own alphabetical scheme. This ribbon is sent to the telegraph office, put on the automatic telegraph machine, and its dots and lines are received at the other end of the wire, and sent, on a duplicate ribbon, to the person addressed. Thus, it may be said, one may buy his telegraph service by the yard. Mr. D. H. Craig, of the New York Associated Press, is largely interested in the development of the system, a practical application of which will soon be made over a Washington and New York wire.

*** The regular monthly meeting of the Baltimore & Ohio Railroad directors was held last week, President Spencer in the chair. The contract executed between the Baltimore & Ohio Company and the Western Union Telegraph Company, on the 5th of October last, was approved. It leases to the Western Union Company all the wires on the line of the road not needed for railroad purposes at a rental of $60,000. The contract defines the rights and privileges of the Baltimore & Ohio Company in reference to telegraph affairs, with the privilege to employ a superintendent. The president was authorized to appoint a committee of five to examine into all the modern devices to prevent fraud in issuing bonds and certificates of stock, and report if additional safeguards are necessary.

*** Electricity has been adopted in St Louis for street car purposes. The Brush motor and the Julien storage battery will be used.

Type Writing and Horse Power.

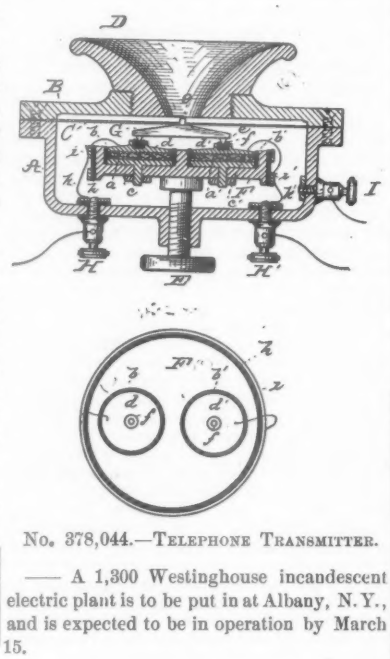
There is no little amusement in a certain electric light establishment in Boston over the ingenious explanation of a mistake made by a girl stenographer and typewriter. Girl stenographers, by the way, occasionally make an odd mistake when they know nothing whatever about the matter that they are "taking." This particular one had had a technical letter to some expected customer dictated to her, and had produced a neatly written typewritten copy of it for the head of the firm to look over. He looked it over.

"See here," said he, after he had read a little, "you make Mr. —— say here that we guarantee to give twelve lights to every horse power. Now, inasmuch as our circulars guarantee to give only eight lights to every horse power, I don't believe that Mr. —— ever could have promised to give these people twelve lights."

"Oh, Mr. —— certainly said so."

"Did, eh? Well, how do you account for the discrepancy?"

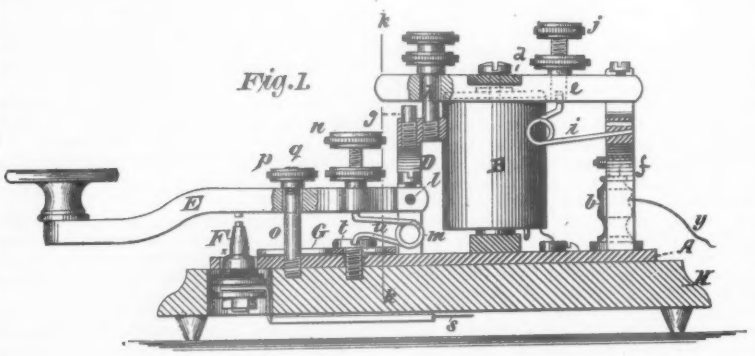
"That's easy enough," said the girl. "The circulars were made when the firm went into business. Since that time the horses have grown. They're a good deal stronger now!"



No. 378,044.—Telephone Transmitter.

—— A 1,300 Westinghouse incandescent electric plant is to be put in at Albany, N. Y., and is expected to be in operation by March 15.

Fig. 1.



No. 377,862.—Combined Telegraph Key and Sounder.

OUR KANSAS CITY LETTER.

(From a special correspondent of the Electrical Review.)

G. G. Moore, James P. Harper, and E. R. Weeks, have been appointed appraisers of the Henry or Fifth street electric railway now in the hands of Henry Tussell, receiver.

All the machinery for the American Electric Light Company has been ordered, and the company expects to have its plant in operation by March. The company will begin operations with a capacity of 75 lights, but will have an engine with a capacity of 200 lights.

Superintendent Bossart, of the Interstate Electrical Supply Company, reports putting in two new storage plants this week.

The Hallett Electrical Illuminating Company expects to be in operation in 60 days. The organizers of the company think this is the best place in America for an electric light company, and think their individual prospects are most excellent.

Mr. W. R. Nelson, of the *Star*, has added another proof of his faith in electricity by adopting the electric clock. He has had one placed in the business office, one in the composing room, one in the stereotyping room, and one in the press room. The Electric Time Company had just begun putting them in last week when the fire broke out that left the *Star* office so bad a ruin. But upon recovering from the effects of the flames the electric clocks were amongst the first things to be put in. The other electrical apparatus in the office was completely destroyed by the fire, but most of it has since been replaced, including the call-bells, telephones, and telegraph. The incandescent lights have not yet been replaced, and the printers, who now set the type by smoking, flickering gas flames, are learning to appreciate the bright, steady gleam of the incandescent.

The Lawrence (Kas.) Water Works Company has purchased the electric light plant, formerly known as Bowersock's. The dynamo will be removed to the engine house of the water works company, and will be run by steam power. Heretofore water power has been used, and it failed frequently on account of low water. G. M.

Kansas City, Mo., Feb. 10.

New Patents.

The following illustrated figures are among the patents issued February 14, 1888:

No 377,862. Combined Telegraph Key and Sounder. New Haven Clock Company, assignee.

Invention relates to form of construction in a simple manner, combining the two instruments.

D is the sounding-post carried by the plate *A*. It preferably carries a stud or anvil, *g*, upon its upper end, which the lever *e* is to strike to produce a clicking sound. The post *D* also carries, or may carry, on a projection thereon, an upwardly projecting guide-pin *h*, which passes through a slot of the lever *e*. The pin *h* carries above the lever *e* nuts to limit and regulate the upward movement of said lever.

E is a key-lever of suitable construction pivoted in the post *D* by means of a pin or other pivot *l*. The post *D* is shown in Fig. 4 to be arched, and the end of the lever *E* passes into said arch, where it is pivoted; but the lever *E* may be supported in any other form of post *D*. The lever *E* is held in its proper normal position by means of a spring *m*, bearing at one end against the lever or against a set screw, *n*, carried by said lever, and at its other end against the plate *A* or a projection therefrom, or against any other suitable support. This spring *m* could, if desired, be adjusted in a manner similar to the spring *i*—that is, have one of its ends supported by the post *D*.

No. 378,044. Telephone Transmitter. T. A. Edison.

My invention relates to electric telephone transmitters, preferably of the class employing carbon buttons; and my object is to produce a simple and efficient multiple instrument of this character.

The case of the instrument is preferably of metal, made in two parts, *A B*, between which is clamped the diaphragm *C*, of metal or mica. The part *B* of the case comes to mouth-piece *D*. Centrally in part *A* of the case is a metal adjusting-screw *E*, which carries a metal plate, *F*. This plate is the carbon button carrier. It is shown as carrying two carbon buttons; but a greater number may be used. This plate *F* has on its face two circular receptacles with metal plates *a a'* in their bottom. These receptacles have rings *b b'* of insulating material—such as hard rubber—which rings insulate the carbon buttons and superimposed plates from the carrier. Upon plates *a a'* are carbon buttons *c c'*, and above these are metal plates *d d'*, upon which bear the arms of a yoke *G*. Points *e* on the yoke arms enter sockets *f*, of insulating material, carried by plates *d d'*. The yoke *G* has on its back a central stud *g* which enters a central opening in the diaphragm and is adapted to turn freely therein.

The periphery of plate *F* is faced with insulation *h*—such as hard rubber—and upon this insulating face are secured metal rings *i i*, one for each carbon button. These rings are connected with the plates *d d'*, as shown, ring *i* being connected electrically by a fine wire with plate *d* and ring *i'* with plate *d'*. Insulated binding posts *H H'* have springs *k k'*, which bear on rings *i i'*.

ELECTRICAL PATENTS

(Copies of any Patents in the following List wil be sent to any address on receipt of twenty-five cents.)

INDEX OF INVENTIONS FOR WHICH LETTERS PATENT OF THE UNITED STATES WERE GRANTED IN THE WEEK ENDING FEB. 14, 1888.

377,745 Galvanic battery; Theodore M. Foote Boston, Mass., assignor of fifty-one one hundredths to Samuel T. Holmes, same place.

377,763 Printing telegraph; Jacob H. Linville, Philadelphia, Pa.

377,788 Telephone system; Edward P. Trayer, and Geo. H. Kugler, New York, N. Y.

377,851 Electric fuse; Perry G. Gardner, North Adams, Mass., assignor of one-half to Russell S. Penniman, Dover, N. J.

377,862 Combined telegraph key and sounder; Bartholomew Oehmen, New York, N. Y., assignor to the New Haven Clock Company, same place.

377,872 Electro-medical apparatus; Theodore R. Ten Broeck, New York, N. Y., assignor to the Galvano-Faradic Manufacturing Company, same place.

377,879 Telegraphy; Clement Ader, Paris, France.

377,884 Current regulator for dynamo electric machines; Walter A. Crowdus and Henry M. Sutton, Dallas, Texas

377,894 Support for electric conductors; Maurice J. Hart, New Orleans, La.

377,895 Secondary electric clock; Wirt B. Harvey, Memphis, Tenn.

377,916 Electric bell; Jacob P. Tirrell, Somerville, Mass., assignor to the Electric Gas Lighting Company, Portland, Me.

377,953 Tubular metallic pole for telegraphic and other uses; Anson Mills, U. S. Army, assignor of one-half to Nelson A. Miles, U. S. Army.

377,994 System of electrical conversion; Edward N. Dickerson, jr., New York, N. Y.

377,995 Dynamo-electric machine; 377,997 Frame for winding armature coils; Rudolph Eickemeyer Yonkers, N. Y.

378,021 Underground electrical conduit; Robert F. Silliman, Troy, N. Y.

378,029 Electric current indicator; 378,030 Telephone exchange central office connection; Ernest P. Warner, Chicago, Ills., assignor to the Western Electric Company, same place.

378,044 Telephone transmitter; Thomas A. Edison, Menlo Park, N. J.

Any person having valuable patents or ideas in Electricity, and not having sufficient funds to demonstrate them, may obtain money and business experience and use of powerful dynamo by writing to Box 356, New York. State date of patent and full particulars.

PATENTS.

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W. J. Buckley, Mgr. Ft. Wayne Jenny El. Light Co.
Thomson-Houston Electric Light, Herbert Wadsworth, Manager Western Office.
Brush Electric Co., Alex. Kempt, Special Agent.
Excelsior Electric Co., C. J. Reilly, Western Mgr.
Sperry Electric Light Motor & Car Brake Co., 201 Royal Insurance Building
J. H. Reid, General Manager of the Mather Electric Light Co., Chicago.
Wm. H. Purdey, Comm. of Public Works, Chicago.
John Mab, Chief Engin'r of Board of Trade, Chic.
C. J. Melmes, Gen'l Sup't Thomson-Houston Light, Omaha, Neb.
J. A. Corbey, St. Joe Electric Light and Power Co., St. Joe, Mo.
Wm. Oswald, Agt. Edison Light Co., New Orleans, La.

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Wound for any circuit.

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The Standard Open-Circuit Batteries of the World.

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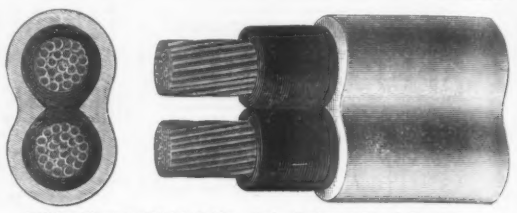
FOR HIGH OR LOW TENSION CURRENTS.

Weatherproof, and "W.A.C." Fire and Waterproof Wire

FOR POLE OR INDOOR SERVICE.



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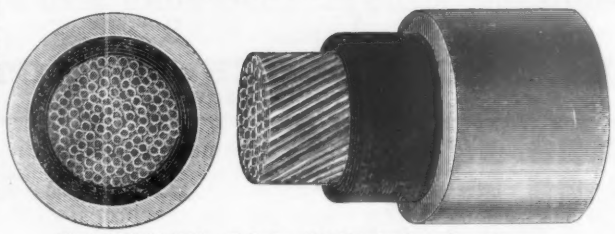

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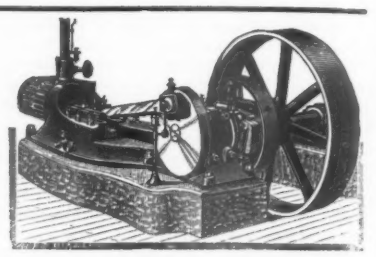

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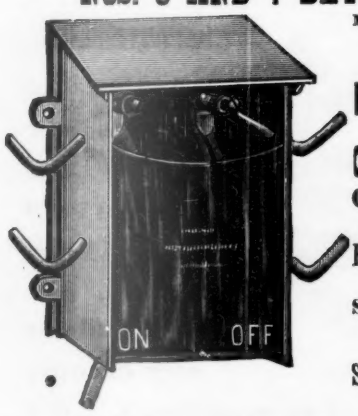

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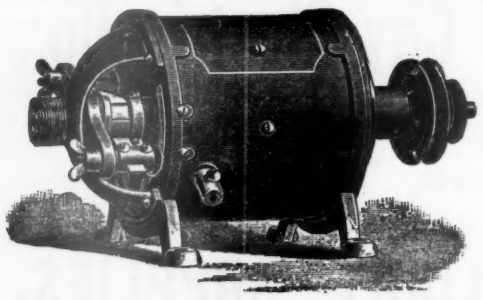

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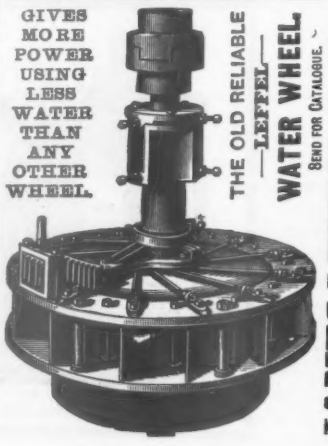

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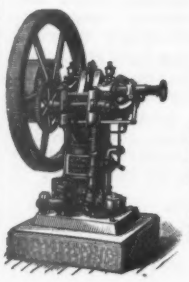

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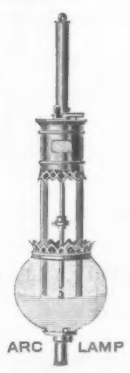

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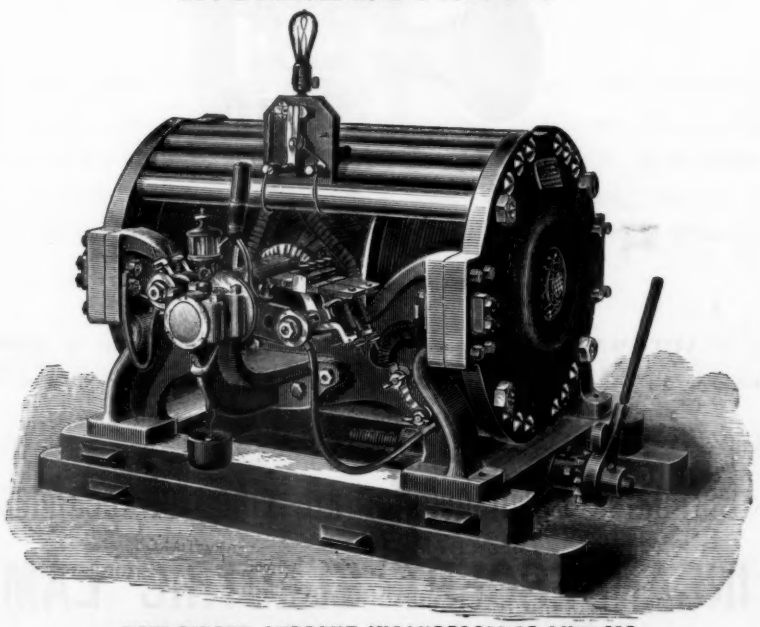

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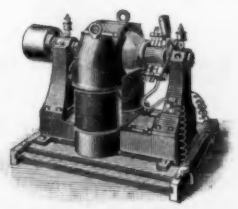

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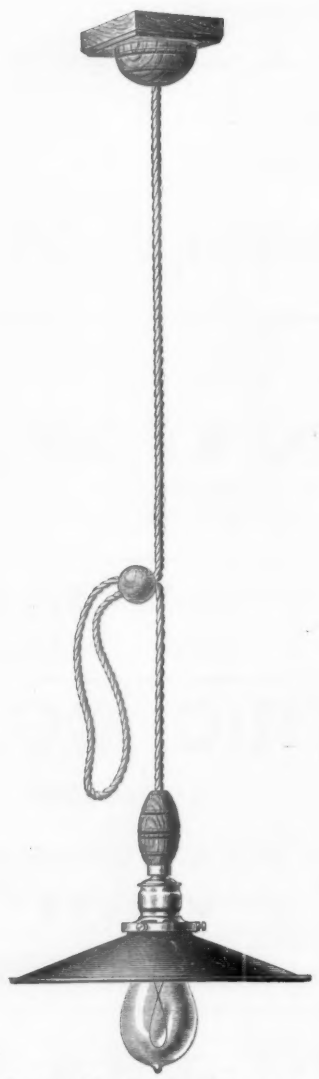

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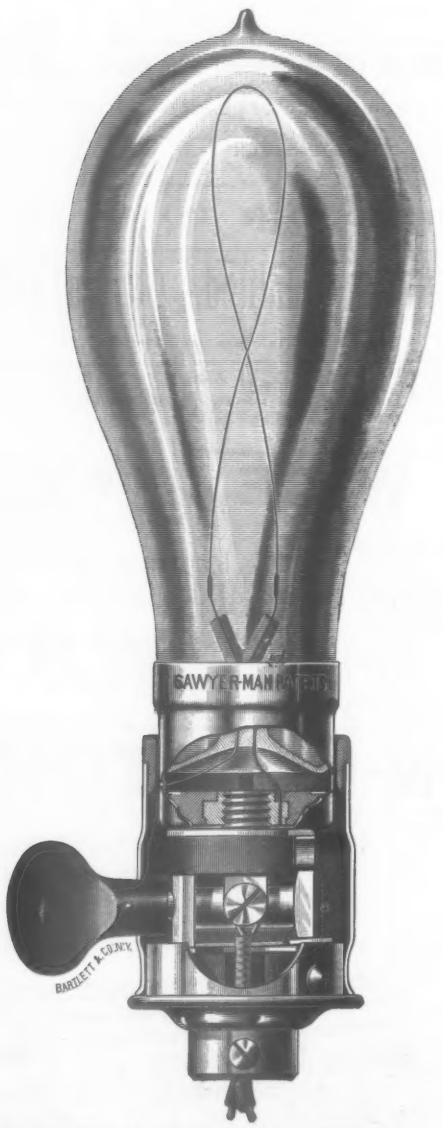

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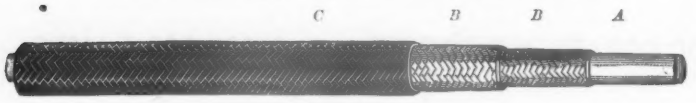

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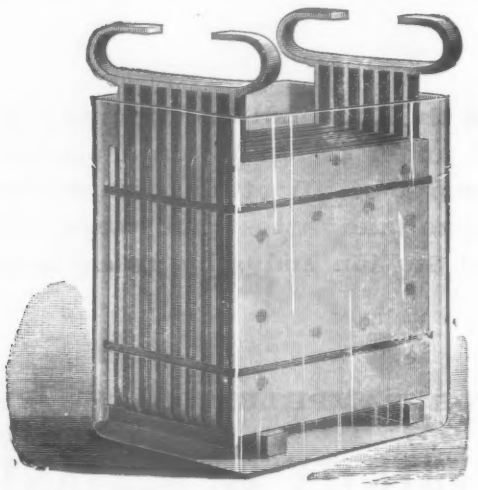

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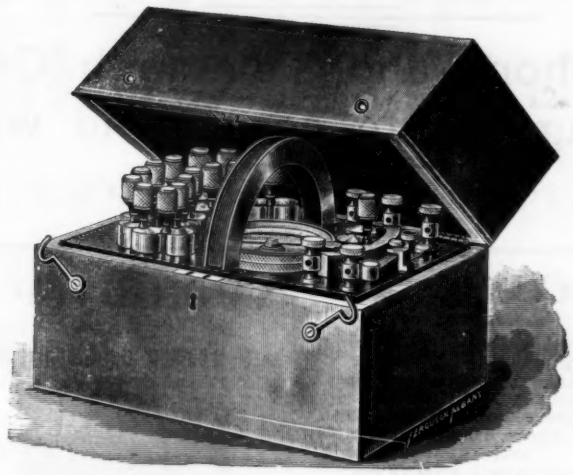

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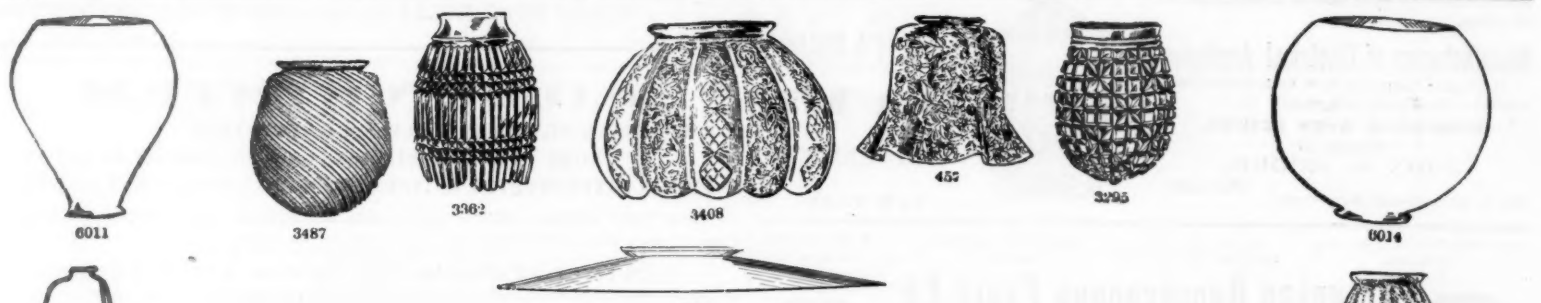

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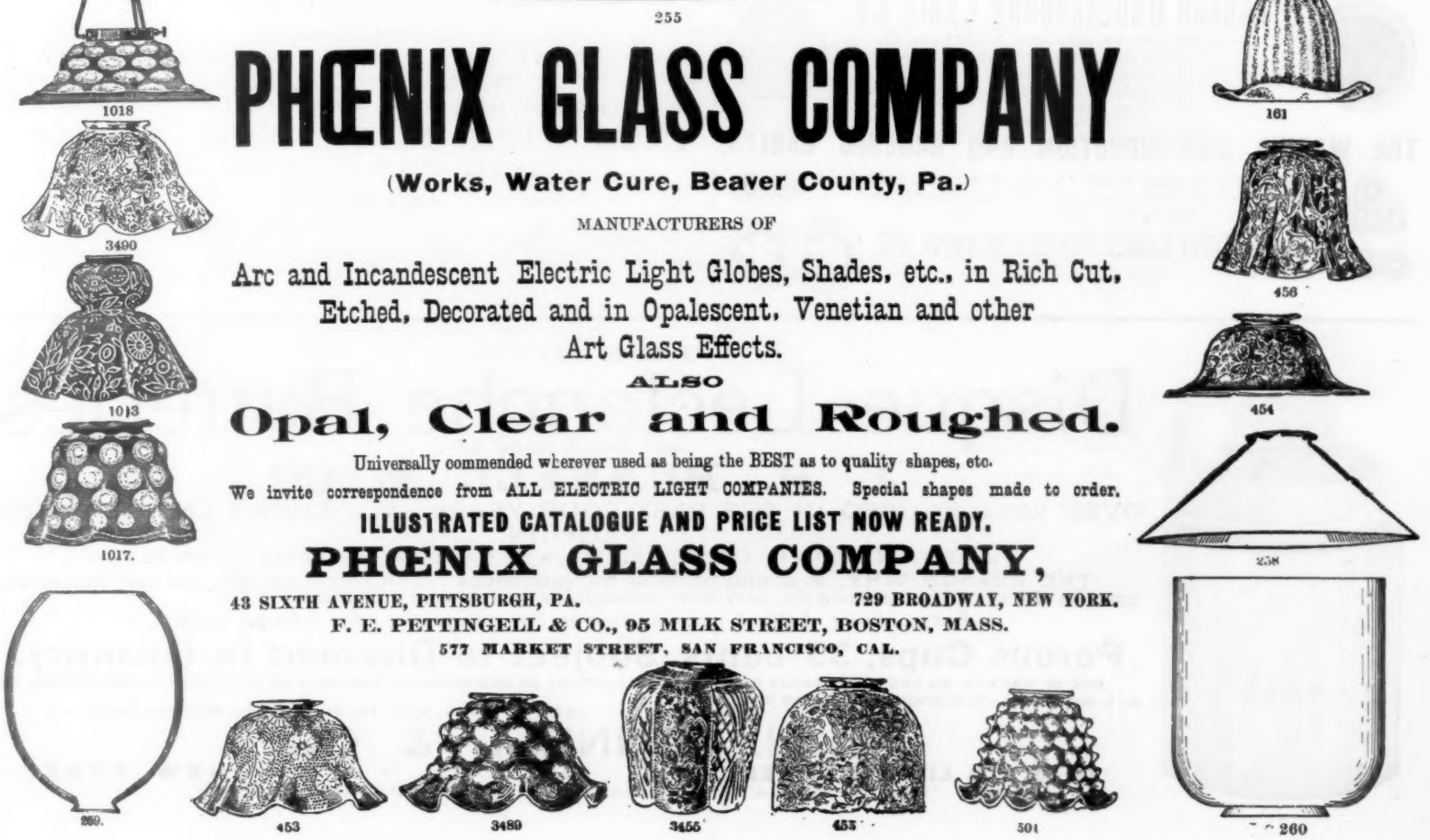

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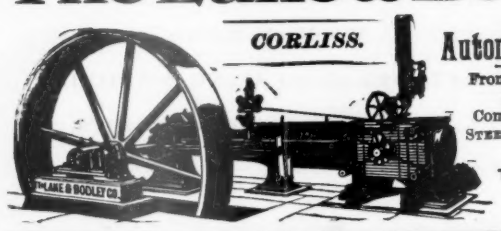

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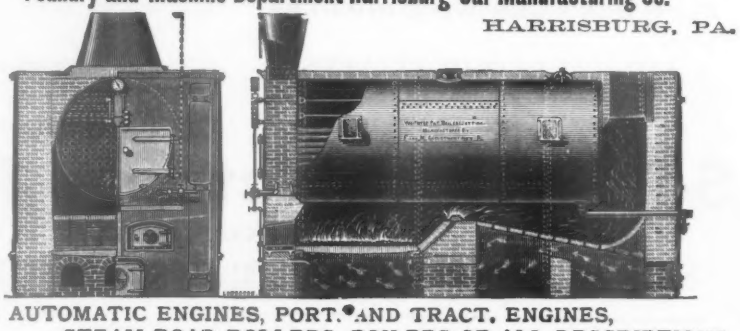

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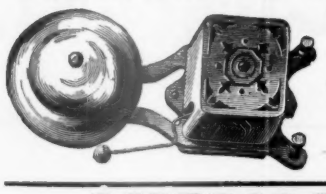

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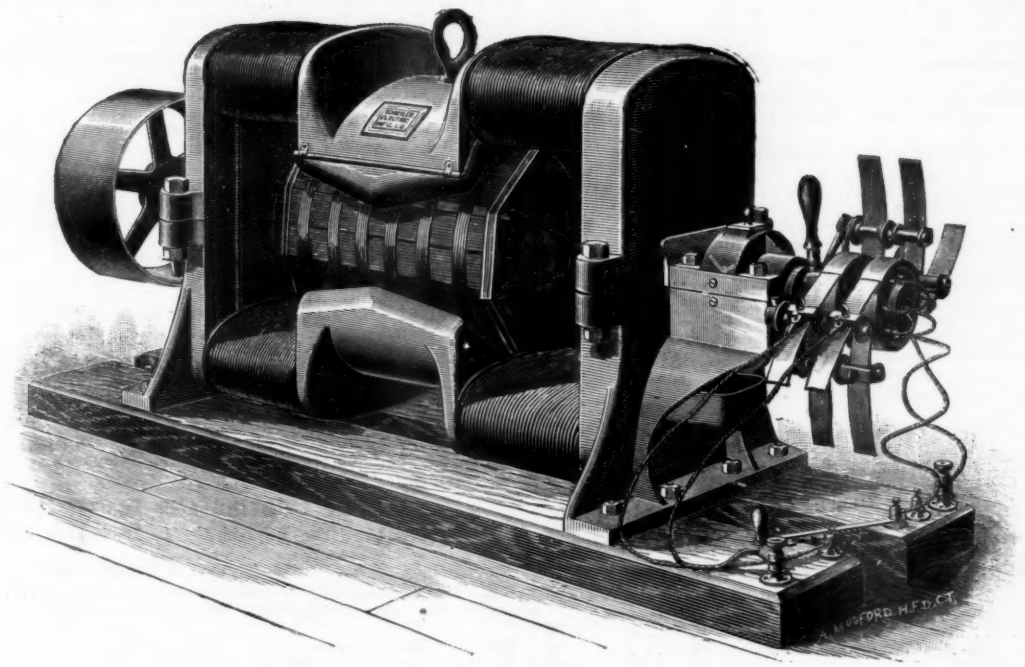

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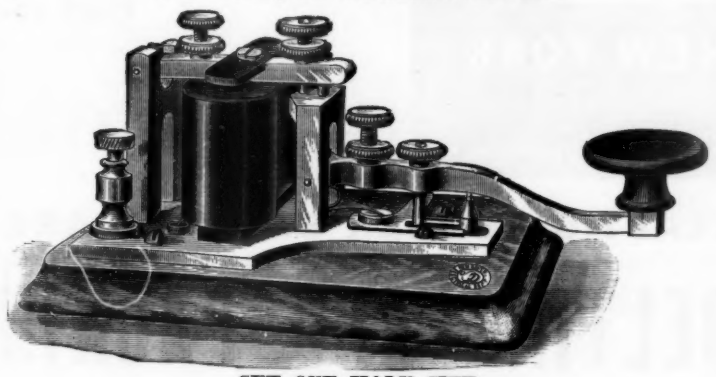

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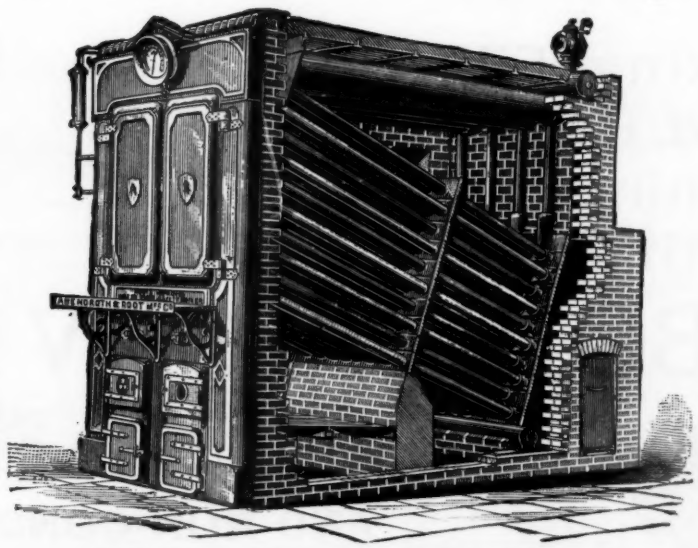

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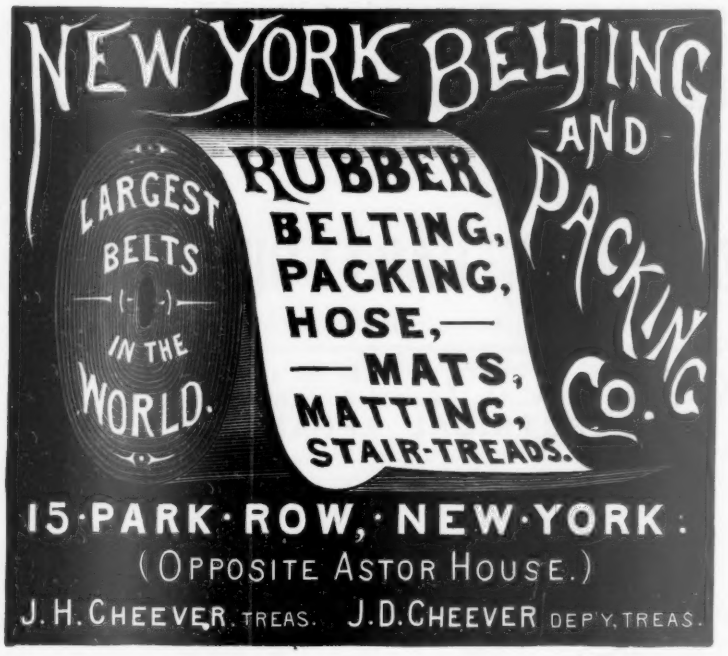
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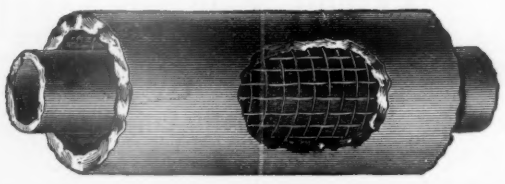

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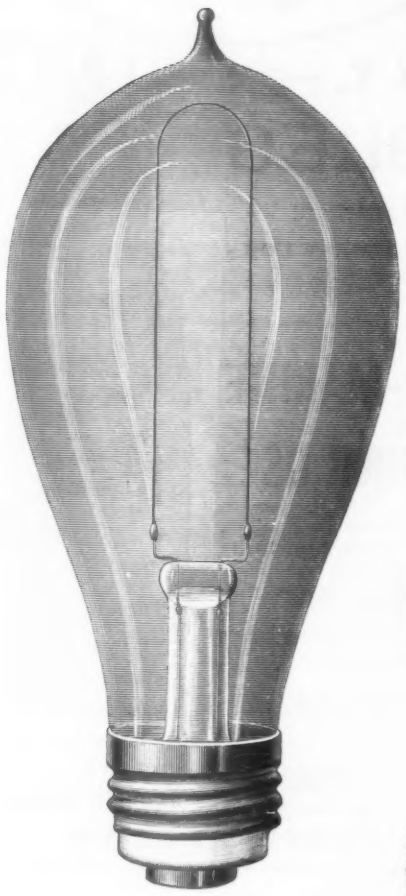

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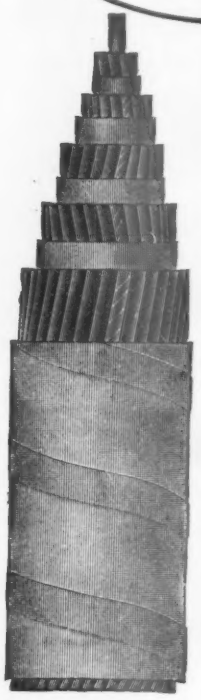

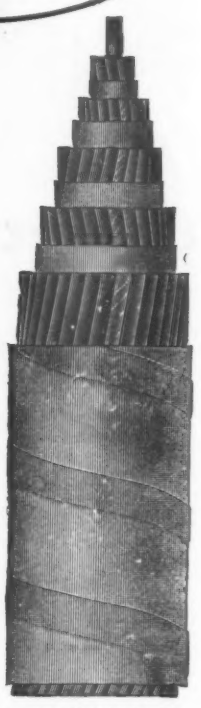

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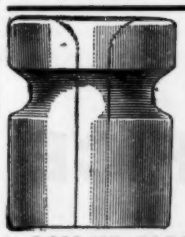

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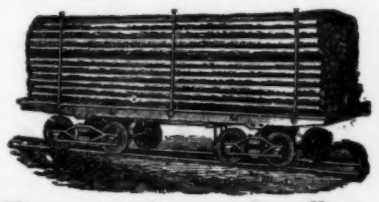

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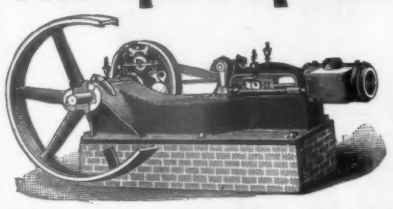

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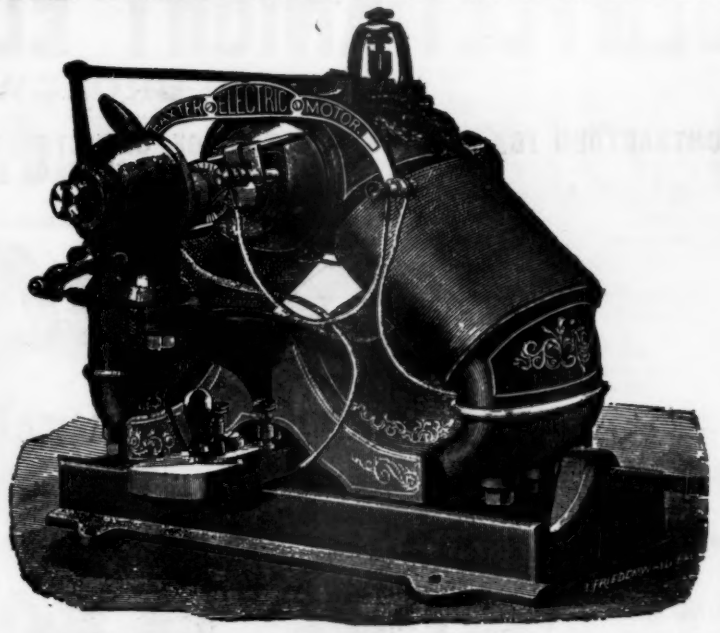

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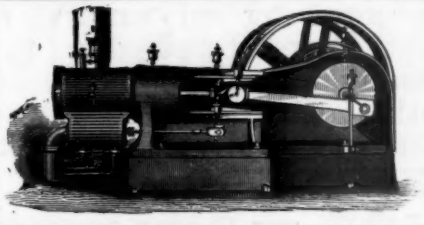

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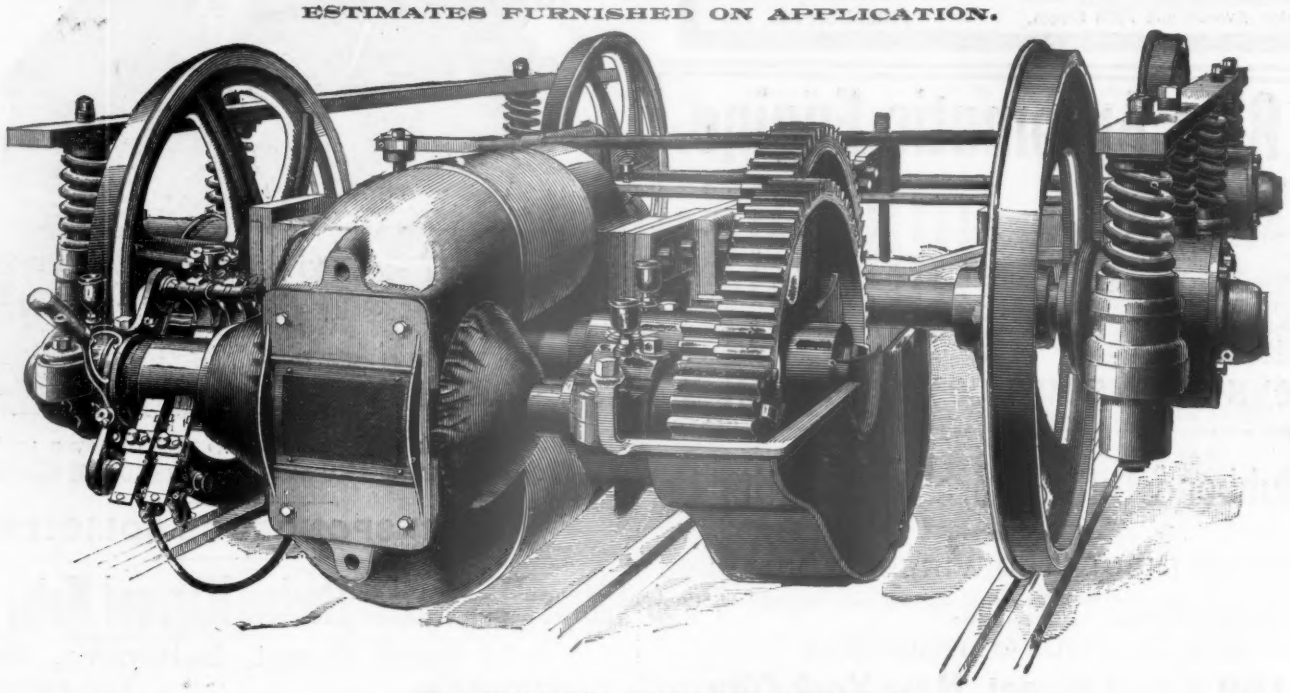

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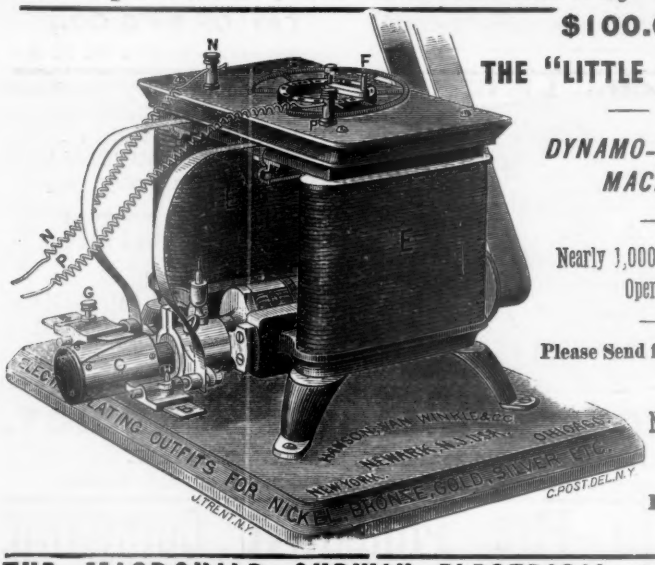

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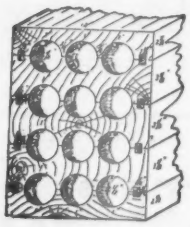

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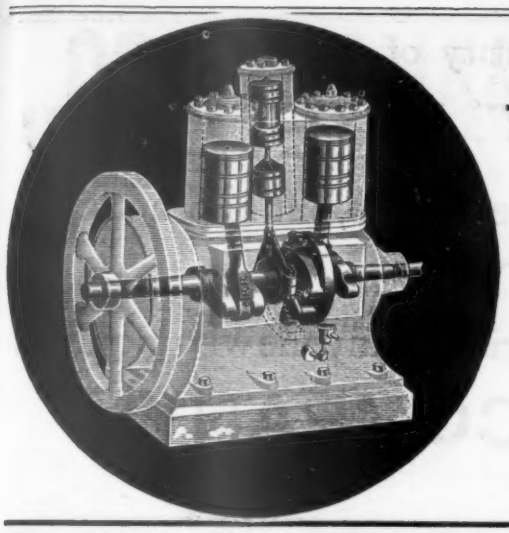

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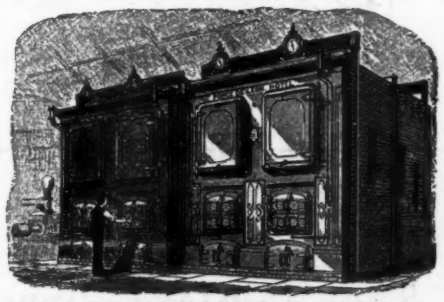

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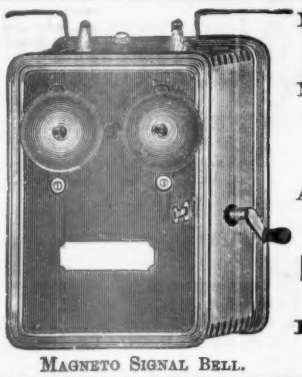

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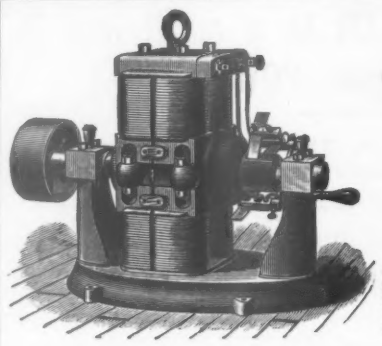

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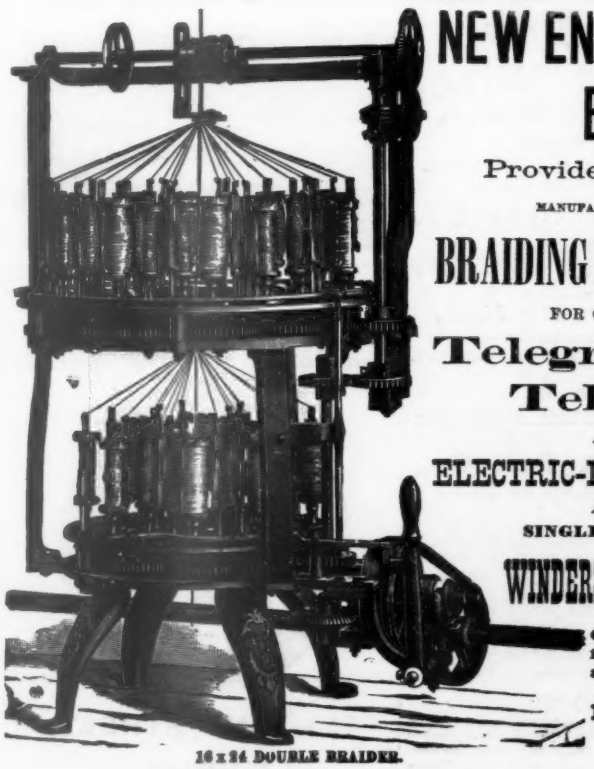

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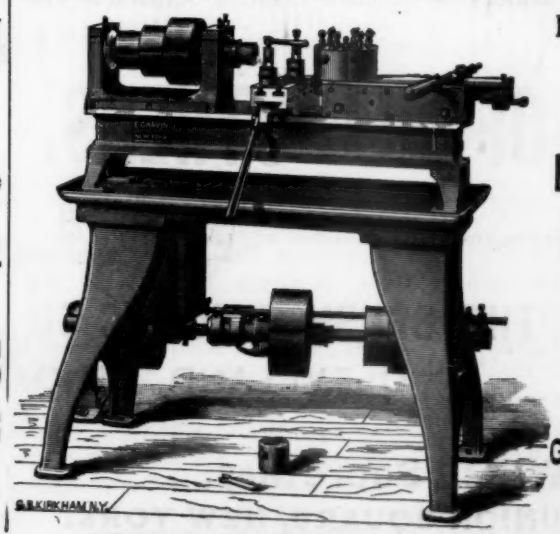

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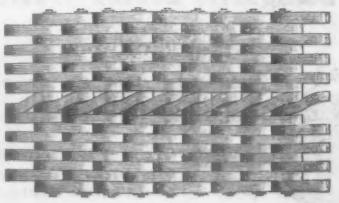

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